Science Education

SCIENCE AS AN ORGANIZED FIELD OF STUDY

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In approaching the discussion of this topic it seems to me important to differentiate between two fundamental points of view. The organization of science may be considered first from the standpoint of the logical arrangement of the subject matter. Such an arrangement results in rather clearly defined areas as physical science and biological science which in turn are composed of smaller areas such as chemistry and earth sciences on the one hand, and botany and zoölogy on the other. Again these subdivisions are made up of smaller ones such as organic, inorganic or physical chemistry and in the case of biological sciences, physiology, ecology, or pathology. In the main these compartments are relatively discrete although some of the recent rapprochements, as for example, bio-chemistry and electronics, to mention only two, may be breaking down some of the carefully tended academic fences.

The second viewpoint is the so-called functional one. This differs from the first principally in that it emphasizes the organization of science in terms of the needs and interests of persons in non-scientific pursuits and in terms of the improvement and enrichment of life in present-day society. In this instance, "needs" is broadly interpreted to include more than material necessities. Considerable emphasis is laid on social and ethical values and on the satisfying of avocational and leisure-time interests. Perhaps most important is the emphasis on scientific procedure as a method for the solution of problems in all aspects of living, and on the attitudes that characterize the scientific worker. This conception of science transcends the formal boundaries of the subject-matter areas and aims to unify the whole field of science as the product of a single-minded search for truth in which one method and one habit of thought characterize all branches and all workers.

Although the two points of view thus described are not mutually exclusive, it is perhaps unnecessary to point out that the acceptance of either one also does not carry with it a guarantee of the recognition of the existence of the other. We have taken the first one more or less as a matter of course. We have not until rather recently come to a realization of the importance of the functional one. Let us consider briefly what some of our leading students have written and said on the question.

Herbert Spencer [1] was a firm and enthusiastic believer in the values of science. After carefully surveying existing fields of knowledge less than a century ago, he wrote: "Thus, to the question with which we set out—What knowledge is of most worth?—the uniform reply is—Science. This is the verdict on all the counts. For direct self-preservation, or the maintenance of life and health, the all-important knowledge is—Science. For that indirect self-preservation which we call gaining a livelihood, the knowledge of greatest value is—Science. For the due discharge of parental functions, the proper guidance is to be found only in—Science. For that interpretation of national life, past and

[1] Spencer, Herbert. *What Knowledge is of Most Worth?* In Lectures on Education. New York: D. Appleton and Company. 1860 (Reprinted 1900), p. 84.

present, without which the citizen cannot rightly regulate his conduct, the indispensable key is—Science. Alike for the most perfect production and highest enjoyment of art in all its forms, the needful preparation is still—Science. And for purposes of discipline—intellectual, moral, religious—the most efficient study is, once more—Science."

Perhaps a little more guarded in its phraseology although still most hopeful was the Science Committee of the Commission on the Reorganization of Secondary Education [1a] when it stated twenty years ago that "Science instruction is especially valuable in the realization of six of these objectives, namely, health, worthy home membership, vocation, citizenship, the worthy use of leisure, and ethical character." The only one of the Seven Cardinal Principles in the attainment of which science instruction was not considered especially valuable was the command of fundamental processes. Had Spencer been a member of the committee, such a serious admission of weakness would surely never have been countenanced.

The number of such quotations could be increased many times with similar statements by individuals and committees. Charles W. Eliot, Julian Huxley, Asa Gray, Louis Agassiz, and Henry Fairfield Osborne are among those whose utterances could be quoted to strengthen the point. Various deliberative bodies, committees and groups of one type or another, have made similar pronouncements. These statements are all characterized by a degree of faith in the outcomes of science which observation of the behavior of modern man, and experimental investigations of science teaching do not so far seem to support. One illustration from an actual school situation may serve to show the difference between what we hope the study of science does for those who pursue it and what actually characterizes some of them in thought and deed.

A high school class in chemistry had prepared oxygen by the usual procedure of heating a mixture of potassium chlorate and manganese dioxide. The properties of the product were tested as usual. (I may say for the benefit of those who never have performed this experiment or who have forgotten it, that potassium chlorate is a white crystalline substance and manganese dioxide is a fine brownish black powder. When the two are mixed and heated, oxygen is produced.) The students reported the experiment in the usual manner. A few days later the class was asked to repeat the experiment but this time they were given materials which strongly resembled the original two but which were incapable of producing oxygen. Nothing was said to them about the substitution. Imagine the feelings of the teacher when the reports were made, upon learning that many members of the class stated that the repetition of the experiment had been highly successful and that oxygen had been obtained just as before. It appears that some of our science students are not learning what science means if this experiment is any criterion.

The difficulty seems to be that in writing about science and in promoting it as a discipline we have spoken as though it were organized from the functional point of view, but we have continued to teach it in the compartmentalized arrangement. We have mistaken the form for the substance. We have given students the facts which science study has amassed but we have failed or forgotten entirely to give them the understanding of and training in the procedure by which progress has come. We have carefully watered and nurtured the barriers between the separate sciences. Scientists often resent and resist what they consider encroachments of workers in

[1a] Commission on the Reorganization of Secondary Education. Report of Committee on Science. Reorganization of Science in Secondary Schools. U. S. Bureau of Education Bulletin, 1920, No. 26.

other fields. We have produced general science courses and survey courses which often consisted of non-miscible layers of frozen liquids which lay in rigid juxtaposition, with a minimum of integration—or shall I say, contamination. In writing about the teaching of science in secondary schools in his monograph on the Senior High School Curriculum, Counts [2] pointed out these weaknesses more than a decade ago. He stated that "the materials (of science courses in the senior high school) are usually organized about the interests of scientists rather than about the interests of high school boys and girls or of ordinary persons—the offerings in a given science aim to give the individual a comprehensive view of *the subject matter* of that science rather than that insight and technique which will be of greatest value to him in meeting the problems of everyday life. The object is to produce the scientist rather than the intelligent citizen."

An examination of current textbooks in science for introductory courses on secondary and collegiate levels indicates that many of them are thicker than, but in organization or point of view little different from, generations of their predecessors. Although many authors give lip service to such ideas, for example, as the unit plan of organization, examination of their work too often leads to the suspicion that reorganization has been confined to the process of combining what once were thirty chapters into ten so-called units of approximately three chapters each.

In his preface to the third edition of a popular textbook for introductory physics for college students,[3] the author states by way of reassurance to us in his opening sentence that, "In this edition the same policies have been followed as in the earlier editions. Perhaps the most obvious change is in the order of topics in the first four chapters." Farther on he says, "Among the various suggestions which have been offered for increasing the educational value of the study of physics is the proposal that we should give more time to a consideration of those methods of thinking which are characteristic of modern scientific methods. Obviously, not much space can be given to such discussions in an elementary textbook without sacrificing other things." Since, in the preface to the first edition this author states that the book is expressly for those who have not had special mathematical training and "particularly for those who are taking physics as a part of a general course in arts and sciences," one cannot help but wonder what these students get that could not be sacrificed in order that thorough treatment of the methods and spirit of science might find a place in the volume.

A few years ago, Beauchamp [4] investigated the teaching of science in selected secondary schools and reported as follows regarding practice in training pupils to use scientific methods and to imbue them with the scientific attitudes. Teachers said in reply to his questions that:

1. The study of science results automatically in this ability because of the nature of the subject matter of science.
2. It is not possible to train a pupil to think.
3. We had a lesson on that last week or we will have a lesson on that next week.
4. We take that up in the introduction to the course.
5. The pupils learn the method by watching the procedure of the teacher.

Beauchamp goes on to say that none of the answers was sufficiently definite to give the investigator a clear idea of what was being done in this direction. This does not necessarily mean that no training in scientific thinking is being carried on but it does mean that such training is not given

[2] Counts, G. S. *The Senior High School Curriculum.* University of Chicago. Supplementary Educational Monographs. Number 29. February, 1926.

[3] Stewart, Oscar M. *Physics.* New York: Ginn and Company, 1939.

[4] Beauchamp, Wilbur L. *Instruction in Science.* National Survey of Secondary Education. Monograph No. 22. U. S. Office of Education Bulletin, 1932, No. 17.

in a systematic fashion. Similar questions may be raised regarding the scientific attitude of mind. Since the schools visited were carefully selected as being outstanding, it is not at all likely that general practice would present a picture more encouraging.

Enough has probably been said to substantiate the statement made earlier that we talk about science as though it were organized from the standpoint of the consumer when actually it is almost universally presented and studied from the viewpoint of the producer or specialist. John Dewey has frequently and seriously criticized science for this. A quotation from an address [5] given by him in Boston in 1933 will summarize very well what has been said here on the point. "The field of education is immense, and it has hardly been touched by the application of science. There are, indeed, courses in science installed in high schools and colleges. That much of the educational battle has been won, and we owe a great debt to those who waged the battle against the obstacles of tradition and the inertia of institutional habit. But the scientific attitude, the will to use scientific method and the necessary equipment to put the will into effect, is still, speaking for the mass of people, inchoate and unformed. The obligations incumbent upon science cannot be met until its representatives cease to be contented with having a multiplicity of courses in various sciences represented in the schools, and devote even more energy than was spent in getting a place for science in the curriculum to seeing to it that the sciences which are taught are themselves more concerned about creating a certain mental attitude than they are about purveying a fixed body of information, or about preparing a small number of persons for the further specialized pursuit of some particular science.

"I do not mean, of course, that every opportunity should not be afforded the comparatively small number of selected minds that have both taste and capacity for advanced work in a chosen field of science. But I do mean that the responsibility of science cannot be fulfilled by educational methods that are chiefly concerned with the self-perpetuation of specialized science to the neglect of influencing the much larger number to adopt into the very make-up of their minds those attitudes of open-mindedness, intellectual integrity, observation, and interest in testing their opinions and beliefs that are characteristic of the scientific attitude."

Up to this point we have presented two contrasting points of view and some evidence, including judgments of various authorities. What then may be suggested as the way out of this dilemma? Certain developments in education today are most promising and suggest that workers in this field are not only aware of these difficulties but that some at least are doing constructive work.

1. There is a serious and evident trend in the direction of shifting the point of view in science education from the logical to the functional. Some of the newer textbooks already referred to, particularly for junior and senior high schools, do show a refreshing tendency to adopt new principles of organization. Functional units, direct and recurring attention to scientific habits of thought, consistent emphasis upon the social implications of natural science, and a tendency toward eclectic organization of science around important and humanly fruitful concepts and generalizations are highly encouraging. The recent volume on Science in General Education [6] of the Progressive Education Association is rich in suggestions for science teachers

[5] Dewey, John. The Supreme Intellectual Obligation. *Science Education*, 18: 1–4, February, 1934.

[6] Committee on the Function of Science in General Education (Commission on Secondary School Curriculum of the Progressive Education Association). *Science in General Education*. New York: D. Appleton-Century Company, 1938.

for the organization of science in the functional areas of personal living, intimate personal-social relationships, social-civic relationships, economic relationships, and reflective thinking. The products of some of the curriculum workshops in the biological and the physical sciences represent distinct advances toward the development of functional science instruction.

In many progressive centers new types of organization for science courses, particularly for non-college preparatory pupils, are being tried. The so-called fusion courses in physical science are a case in point, although they actually represent nothing new since general science and biology in secondary schools have for some years been widely accepted as improvements over physical geography and separate courses in botany and zoölogy. A course which has developed in the high schools of Cleveland over the past ten years is described by Bush.[7] It is pertinent in this discussion and may be referred to briefly. The work of this course is open to eleventh and twelfth grade pupils and differs from the conventional courses in physics and chemistry in three ways. In the first place it entirely disregards the conventional boundaries. Second, it aims to give "scientific consumer education." Third, it emphasizes social implications. One illustration may suffice. In the study of the airplane, emphasis is placed on its uses in fishing, fire patrols, exploration and the like. Size, speed, safety, controls, etc., of passenger planes are studied. This is contrasted by Bush with that which might be studied such as "thrusts, drags and lifts, combinations and resolution of forces, parallelograms and resultants." The course differs from general science in the junior high school in the maturity of outlook and, where duplication occurs, as is inevitable, in more extensive and informal treatment. It may be added that where this course has been given, the enrollment of eleventh and twelfth year pupils in science courses has doubled. The same pupils still take chemistry and/or physics, but at least an equal number who have not taken either now take the new course.

2. There is heartening evidence that teachers themselves are not satisfied with the stereotyped, cellophane-wrapped science courses labeled, "To be seen but not tasted." One or two illustrations may be cited. Linderman[8] organized the work of a second grade group entirely around four units in science. These were, a balanced aquarium, a vivarium, a pair of guinea pigs with young, and a setting hen and the chicks she hatched. All the work of the class including reading, writing and number work was centered around these activities. Besides learning much science, at the end of the year the children were above grade in every part of the New Stanford Achievement Test as well as the Gates Primary Reading Test. The experimenter felt that the attainments in attitudes and socialization were better even than the subject matter gains.

Another experiment by Bradbury[9] may be cited as evidence of what can be done with junior high school pupils. Two classes in ninth-grade general science were the subjects. The average I.Q. of the control group was 93, of the experimental group, 116. The two groups were selected by teachers as slow and superior respectively. The score of the slow group on the Dvorak Test in General Science at the beginning of the year was 85—of the fast group, 91.5. During the first semester the fast group was taught by a teacher of five years' experience according to the following method. The first ten minutes of each

[7] Bush, George L. "Symposium: The Need for a Twelve-Year Science Program for American Public Schools." *Science Education*, 22: 66–68, February, 1938.

[8] Linderman, Haziel. "Units of Work in Nature Study for Grade Two." M.A. Thesis, University of Colorado, 1936.

[9] Bradbury, Bernard S. "A Pupil-initiated Course in General Science." M.A. Thesis, University of Cincinnati, 1934.

class period were used for written or oral quizzes reviewing the previous day's work. The next twenty minutes were used in discussing the assignment for that day. Then came the next day's assignment with questions for study and a twenty-minute study period. Two of the five periods per week were given to laboratory work consisting chiefly of teacher or pupil demonstrations. Many laboratory exercises consisted of written work following the text and the questions in the laboratory manual.

In Group II, the following principles were considered basic: (1) use more than one text, (2) do as much experimentation as possible, (3) follow pupils' interests, (4) pupils select and perform experiments, (5) insist on a list of references for each topic, (6) make pupils feel responsible for the course, (7) permit expression of pupil ideas or originality at any time.

The first two weeks pupils simply got acquainted with the books available to all (at least six). No assignments were made. Pupils read, performed experiments, discussed, or did what they wished. By general agreement the class decided to work on one topic to begin the third week, namely, air. The general procedure thereafter was:

1. Selection of a topic.
2. Preparation of individual reference lists and their combination for the class.
3. Discussion by individuals of points of interest.
4. Performance of experiments and discussion of results.
5. Discussion of any related topic.

The instructor made notes of all that happened. In general an opportunistic method was followed. Pupils were encouraged to bring in topics, or materials and the teacher simply guided the work into some sort of organization. A bulletin board was much used by pupils to post references, clippings, and pictures. The pupils wrote reports of laboratory work in a form devised by themselves and scored by a sheet they also devised giving values for each part of the report.

At the end of the first semester Powers General Science Test was given to both groups. Following this the instructors exchanged classes for six weeks. Pupil preferences were asked for before and after the exchange period.

The median score on the Powers Test was 48 for Group I and 47 for Group II. Most of the pupils in both groups favored the freedom method. The slow group in addition to the things mentioned, made apparatus, brought in original experiments, made scrapbooks, organized committees, kept records of articles brought in, made out some of their own tests and often conducted the class work.

Singleton [10] reports that in general science two groups equated on intelligence, knowledge of science, and on various tests of personality and character were taught by two different methods. One group had conventional instruction consisting of a sixty-minute period of which twenty minutes were spent daily in supervised study. The other group had considerable freedom in planning its work with no one textbook and no monthly grades or tests. The experiment lasted throughout the school year. At the end, the activity group was consistently, though not statistically, superior in all but one of the measures of character and personality and equal to the conventional group in achievement as measured by the Ruch-Popenoe test in general science.

These experiments indicate that it is possible for an experienced teacher to conduct science classes with pupils enjoying a much greater degree of freedom and self-direction and with less regard for the conventional organization of subject matter,

[10] Singleton, H. C. *A Comparison of the Changes in Pupils' Character and Information Resulting from Instruction in General Science by the Activity Method versus the Traditional Recitation Method.* M.A. Thesis, Pennsylvania State College, 1935.

than has perhaps been thought possible or desirable. In such classes it appears that the knowledge of subject matter attained is equal to that of conventionally-conducted groups and that other, at least equally desirable results are attained in substantially larger measure.

3. A strong and growing tendency to submit problems of science teaching to experimental study is clearly evident. The results of hundreds of investigations have been reported in the literature of the last two decades. Many experimental investigations in the form of graduate theses remain unpublished and, unfortunately, never become generally known. The work of Curtis in furnishing digests of such investigations, and of periodicals such as *Science Education* and *School Science and Mathematics* in rendering similar service is most helpful and significant. Important documents such as the Thirty-first Yearbook of the National Society for the Study of Education [11] and the Report on Science in General Education, already referred to, are of great value in the problems of selection and organization of content where guidance and leadership are perhaps most needed.

Substantial progress is being made in the evaluation of science teaching. Measurement is the handmaiden of all educational research. Without it, attempts at reorganization of science must ever remain incomplete. Many of the values claimed for science study are in the realm of the less tangible outcomes. Those interested in this field have always believed in these benefits. It is only recently, however, that visible progress has been made in their measurement. The work of such men as Tyler, Frutchey, Hendricks, Horton, Geil and Raths is outstanding. They have emphasized especially that in any evaluation program it is essential first to define clearly the outcomes that are to be measured. Often this is half the battle. They have brought out also the important influence of tests upon teaching, the often unrecognized fact that when we devise measuring instruments for certain qualities we thereby create a strong incentive for teachers to emphasize those same outcomes in the classroom. The tests devised by leaders in this area for the measurement of ability to apply principles, to interpret experimental data, or for such outcomes as scientific attitudes not only provide instruments for measuring results of teaching but they also act reciprocally in that they call these things to the minds of classroom workers.

4. Finally, there can be no doubt that we are getting at one of the major roots of this problem in the studies of teacher education. It is almost axiomatic that teachers teach as they were taught. Many students of this question feel that in spite of professional training, student teaching and nearly all else that we do, teachers still are influenced more in their own practice by what was done with and to them in the grades by their own teachers than by all that is given them by teacher training institutions later. It is not too much to hope that out of such investigations as the Study of Teacher Education under the auspices of the American Council on Education will come valuable suggestions not only in the general field of teacher education, but also for those concerned primarily with the education of science teachers. There is no more crucial point in the whole picture presented here today than the proper training of science teachers. When science teachers are trained in science courses that are functional, they will begin to think in terms of functional courses for their own pupils. When science courses in teacher-training institutions emphasize the method and spirit of science rather than blind authoritarianism and cook-book procedures, prospective teachers will begin to understand what science means and be able to convey some of this meaning to their own pupils.

[11] National Society for the Study of Education. Thirty-first Yearbook. Part I. A Program for Teaching Science. Bloomington: Public School Publishing Company, 1932.

DEVELOPING PROBLEM SOLVING ABILITIES IN STUDENTS

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Science literature, for a long time, has stated that problem solving should be one of the major objectives of science education. But little has been accomplished in the classroom with respect to the realization of this outcome because teachers have assumed that by teaching the facts, problem solving abilities will result as a by-product. Evidence indicates that students in the classroom have not learned very much about the problem solving method. This is a serious indictment against science teachers because it is they who have been educated in the method, presumably, and should be better able, than other teachers, to direct the development of problem solving abilities in students. The question then is, what can science teachers do to improve the learning situation? The suggestions given in this report are those which one school has found to be valuable in developing and teaching the scientific approach in the solution of problems in the classroom.

PROBLEM SOLVING ABILITIES TO BE DEVELOPED IN THE CLASSROOM

If a knowledge of the problem solving abilities are to be developed first in the classroom, it is necessary for the teacher to identify these so that a direct approach may be made. These abilities have been defined by other educators so that no attempt will be made here to redefine or modify them. However, in College High School, the secondary research-laboratory school of Colorado State College of Education at Greeley, the science teachers have attempted to ascertain the learning procedures and to utilize a method of approach to the teaching and learning of the problem solving method. That is, we have tried to become aware of the ways of teaching students to recognize problems, to state defensible problems, where and how to obtain first-hand information, how to evaluate data and sources of information and how to teach boys and girls to generalize. A systematic learning approach is made to all of these abilities throughout the period of the child's education in the secondary school.

In this school cooperative teaching and learning with teachers and students have aided materially in developing the problem solving method in the classroom. Through a developmental procedure, with the teacher as a guide in the thinking process, problems are defined for study. Cooperative planning is done with respect to the selection of methods for solving the problems, to the development of skills that are necessary for carrying out the proposed methods and to the techniques for evaluating the results of the learning. This procedure is imperative if the teacher expects to foster problem solving techniques that involve careful planning and the use of appropriate procedures and skills. Then too, it is one of the most effective ways to teach boys and girls how to become self-directive in their learning as they proceed through the years of school life. They gradually learn what to do and to rely on their own judgment of what constitutes effective learning.

Since the recognition of a problem is the first step in the method of learning, students must be given the opportunity to assist and to propose problems for study. This has been brought about in several ways. First of all a group of eighteen students comprise a curriculum committee in the school. Through the assistance of parents and teachers, this committee makes recommendations of what they feel education should do for them. The results of these discussions are then presented to the

advisory groups in the school. Such pupil discussions, on the functions of education, have revealed areas in science which seemingly have been of interest and value to them.

Another area, which is a fertile source of problems for the science work, is the field of the biological and social needs of adolescents. Through the guidance work of the school and through curriculum offerings, it has been found that need and interest have been manifested in the care of the human body, personality development, boy-girl relationships, choice of a vocation, family relationships and problems of marriage. All of these are used as areas from which problems with students are proposed and defined. Students are taught to recognize their own health needs and their personality problems such as, "Why do I behave as I do?". Then too, it has been necessary to analyze some of the basic social-scientific needs of society such as the individual's and the group's need for food, clothing, shelter, transportation, communication, earning a living, getting along with others, planning and maintaining a home, maintaining health and the like. Also, our own community has presented problems to us in which the students have cooperated both in obtaining information and in the proposals for the solution of these problems.

It thus becomes evident that ready-made problems are not presented to students but rather situations involving problems are utilized to develop the ability on the part of students to recognize and define problems. If this ability is to be developed, students must be placed in direct contact with situations that present a challenging problem or one in which they see some reason for solving. This first procedure is a difficult one, but it is not without reason to expect teachers to develop this ability if they will cease depending upon a single text as the only instrument for learning.

A developmental-discussion technique is used to analyze the problem for study. The situations and incidents involved are presented in logical order so that the students can see some relationship between them. The students are then given the opportunity to state that relationship in the form of a unit problem. The problem must be evaluated for its correctness and comprehensiveness. Criteria are set up with the help of students who decide what standards a unit problem must satisfy. Usually these criteria are: Is it worthwhile? Is it comprehensive? Is it one within our scope of learning? Does it emphasize only one idea?

After these criteria have been satisfied, the unit problem is analyzed into subsidiary or minor ideas which become the basis for the contributing problems. These latter problems must be evaluated by the same criteria as were used for the unit problem. However, in addition to these, each contributing or subsidiary problem should involve one important phase of the unit. These problems are next arranged in logical order by the students so that sequential learning takes place.

The next step in the learning process is the determination of the ways or sources for obtaining first-hand information for the solution of each problem. All possibilities for solution offered by the students are accepted and other possible procedures are presented by the teacher. Possible sources for information that may be suggested are: interviewing some authority in that field, experimenting, conducting a survey, observing demonstrations, slides, films, charts, pictures, bulletin boards, obtaining data from a field trip, listening to the radio, reading books, magazines, newspapers and statistical reports. Oral reports and panel discussions may also serve as valuable sources for information. Needless to say, not all of these are utilized in any one unit but sometime during the secondary school education each student has come in contact with each of these procedures.

An individual record is made in writing so that each student has a study plan. He writes out his own study plan using the learning procedures which have been designated as reasonable techniques or he may select others for the solution of the problem. This process is usually done under teacher supervision but as students proceed under this kind of education they become more adept at devising original plans.

Most of the formal teaching is concerned with the teaching of method and evaluating techniques. Subject matter is presented by the teacher when the source for obtaining it is not available. An example of a teaching procedure will be given which is comparable to all others used in the classroom. If experimentation is the first learning technique to be used in solving one of the problems, the class is taught the scientific procedures for obtaining information in this manner. The learning situation to be worthy of the name of an experiment must have a definite stated problem, the experimental factor must be determined, controls for the experimental factor devised, suggestions for recording and summarizing the data, verifying results, plans for the use of materials, conditions for obtaining data and the length of time for continuing the experiment must be stated. These are definitely taught and planned for before the student begins his experimentation. For younger children, this teaching procedure may require several days' lessons but if an understanding of what experimentation means is to be attained by the student, sufficient time, careful teaching and supervision must be given. Other examples are cited to illustrate the type of learning to be done. If the students have decided to use the interview technique, they must first decide whom they will interview. This involves the formulation of criteria for selecting the person to be interviewed and the techniques for conducting an interview. Where reading is utilized as a learning technique, the student is taught how to locate books through the use of the card catalogue, how to evaluate science books, how to use reader's guides to obtain recent information, how to use encyclopedias and other source materials. Whenever there is sufficient reading material for the group, reading skills are taught so that they can learn to read and interpret scientific information. With similarly planned procedures all other techniques are specifically taught for and followed by evaluation and guidance by the teacher.

Careful, systematic teaching and cooperative planning is made for the subsequent steps of problem solving as selecting important ideas, forming conclusions, evaluating conclusions and applying what has been learned. This formal approach is defensible if it aids the individual in becoming more and more self-directive in his learning, in developing initiative, and critically evaluating what he is doing.

As the students follow through either with the group unit plan or an individual one, the teacher must be alert and on the job continuously to direct the activities. As definite learning techniques are needed for continued progress these are taught. As the students gather their information through experimentation, reading or interviewing they are taught how to organize the data in table or graph form, how to write paragraphs and sentences, how to write and select the important ideas and how to generalize.

The psychological processes of analyzing and synthesizing the assembled information involves difficult steps of learning for the student. One procedure has been found helpful in this phase of learning. The student may be taught to summarize the main ideas from each experiment, from each reading source or from the interview. These subsequently may be formed into more comprehensive meanings. This involves the process of generalizing and here the student is directed to note similarities

and dissimilarities among the ideas presented in the assembled sentences. Before the generalization is accepted, the student must decide whether it is based upon the data which he has obtained, whether it is stated in correct English form and whether it answers the problem. He can further verify his conclusion by obtaining more information, by applying it to a concrete situation, by interviewing an authority, by experimenting or by reading another authoritative source. The latter procedures have been found to be very helpful for showing the student how necessary it is to obtain an accurate, reliable and sufficient amount of data and how important it is to base conclusions on the evidence which he has obtained. After the tentative conclusions have been verified in one of the above ways, it becomes the final conclusion to the problem. If problem solving procedures and conclusions are to change the behavior of the student, these must be applied in his everyday experiences. Therefore, problem solving procedures must be utilized in classes wherever the method can be used and in the activities of the school where students are faced with problems.

FURTHER IMPLICATIONS OF THE METHOD

The steps and elements of problem solving are not taught as such but as the student proceeds through the educational experiences of the school, he learns to use various techniques which enhance his learning. After each new technique that has been used, the student is asked to review the procedure, to determine where errors and mistakes were made in its use and to ascertain the salient points of the method.

Again these abilities are presented gradually and progressively throughout the educational experiences of the student. With younger children, one can begin with the formulation and evaluation of problems, with the critical evaluation of sources and with the simpler ways for obtaining information. With older students this process is shortened and many of them can devise ways and means of their own.

Under such a program of education the teacher cannot cover as much subject matter as other teachers may cover by a factual method of learning. But the amount of subject matter covered will have to be sacrificed if educators believe that the ability to solve problems is a more important outcome of learning.

From the observation of students in this school, there seems to be a tendency for them to get at the bottom of the problem which faces them and to solve it on the basis of fact rather than on the basis of emotion. The students become increasingly self-directive; they can handle themselves well in public meetings and present their facts and conclusions in an acceptable manner. They have become increasingly interested in their own learning. They are becoming more able to select their units offered in the general education program on the basis of need. Though this has been fostered by the teachers, yet the students themselves give evidence of making more and better intelligent choices in the planning of their educational program.

Just how far these procedures extend into the solution of other life problems of the individual is not definitely known. However, some evidence has been noted which indicates that there is some transfer. Many of the students attack the problem of selecting a vocation or earning a living in a problem solving manner. What to do with leisure time has been decided by some in an intelligent manner. Susceptibility to advertising over the radio, and to propaganda met in the community and in the home has been lessened as evidenced through pupil and parent comments. Not all of this change in attitude has come through direct application on the part of the student alone but plans have been proposed in individual consultation with the teacher and others who cooperate in the guidance program of the school.

Also, through the teaching method used, students are reading scientific material more widely. These include popular science books, biography, historical science and specialized books written by recognized authorities in the field. A recent inventory of recreational reading revealed the fact that the majority of students in the first two years of the secondary school have read as many as ten to fifteen books, since the beginning of the year, that involve some phase of science. This is in addition to other books of leisure time reading.

Whatever merits the above procedures have, can be decided only through its use in many schools. Promising results are evident in those schools where the problem solving method is attempted as a defensible way of learning.

A PROGRAM OF ACTIVITIES DIRECTED TOWARD ENRICHMENT AND COHESION OF THE SECONDARY SCIENCE DEPARTMENT

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It should be indicated that this article is not concerned primarily with the content offering of a particular course of study in our secondary science education; rather, an attempt shall be made to discuss a program of activities, some of which we have tried with success in our science department, and included, will be certain procedures which we anticipate putting into operation in the near future.

To establish a general contrast of pictures, permit me to begin with some encyclopedic statements. Broadly speaking, the secondary science department is considered well organized and functioning smoothly if the following or similar general conditions prevail: (1) if standardized courses are offered in a capable manner, (2) if a harmonious attitude exists among the faculty and their students, (3) if disciplinary problems are reduced to a minimum, (4) if routine matters, such as inventories, budgets, et cetera, are kept up-to-date, and reports submitted to the office on time, (5) if various science clubs are organized and appear to be "getting along" in a satisfactory manner, (6) if the graduates pass college entrance or other necessary examinations, and (7) if the science department occasionally cooperates with other departments in a project. This list, I presume, could be considerably extended.

Suppose we consider the department from the following point of view. In the usual situation, the science department is organized into a series of sharply defined and particularly named courses for instruction and offered at various year levels in the school career of the student. Likewise, clubs are organized with the view of centering their activities about a particular division of science. These clubs are designated by terms, such as "The Biology Club," and/or "The Chemistry Club." Once the department is organized into classes and clubs the segregated groups remain as a unit throughout the school year, with little opportunity to intermingle, for scientific or social purposes, with their fellow science students from another group.

The question may be asked, does the above constitute a well-organized science department? Perhaps it may, if the acme of the department's motivation is to transmit to its students a certain amount of scientific information, and to function with reduced friction between its members.

If the department goals or objectives are projected no farther than the presentation of scientific facts, regardless of how capably they be presented, the day by day task may become progressively deadening for in-

structor and student alike. In many instances, after the thrill of the introduction to a course is over, the instructor is cognizant of the student let down. Whereby he may redouble his effort to instill into the minds of his students scientific methods, laws, principles, generalizations, and concomitants. The instructor still realizes that many students seldom and, in some cases never, show an interest or comprehension of science. While the student is soon liable to see science as a mass of facts, laws, et cetera, to be mastered in order to pass certain examinations. It is my belief that students have the right to look upon the science department and its contributions in a more interesting and meaningful manner.

Now, suppose we consider the department from a different point of view. The writer is disposed to think of a student in the department, not only in terms of his being associated with a particular class or club, but also as a part of the entire science department. I believe the science department should be thought of as a federation of groups, and, without a doubt, there is much to be said in favor of bringing the several groups, classes and clubs together for mutual purposes and interests.

Again, if we as educators accept the viewpoint of the new education, we see our students as possibilities to be developed into educated laymen, who may intelligently associate themselves with our democratic social order, to their own satisfaction and the well-being of the group of which they are a part. This being accepted as one of the worthy goals toward which we direct a student's general education, it seems obvious that the secondary science program should be enlarged to give more opportunities than most departments now offer for student participation in scientific activities, having social values, and which are fostered and promoted by the students themselves. Any such program of activities which is put into operation must be sufficiently significant and effective to embody themselves into the students' thinking strongly enough to enable them to develop the ability and to unify their behavior for living in a democracy.

Maintaining the opinion that it is desirable to incorporate training, leading to social as well as scientific value, into the scientific experiences of our secondary students the program which follows makes it possible for them to pursue this acquaintance which should contribute toward the unified education of the individual.

The program is being developed with the view to accomplishing the following large objectives.

1. To develop the ability for living in a democracy.
2. Enrich the department's contributions to its students.
3. Foster department cohesion.
4. Encourage tolerance and friendliness among students.
5. Teach students to work pleasantly and effectively with other people.
6. Make decisions wisely.
7. Discharge responsibilities faithfully.
8. Increase student interest in science.
9. More student participation in science activities.
10. Aid students to plan carefully.
11. Present opportunities for forming new friendships.
12. Offer interests which may encourage students to remain in school until graduation.
13. Bring the school and community together.
14. Enable the faculty to become better acquainted with outstanding students in the departments.

Before launching into a description of the program of activities, may I reiterate, it represents the effort of the students. The faculty act in the capacity of adviser when needed.

THE PROGRAM

I. Club Meetings.

In addition to the regular activities of the individual clubs, three general plans are in effect. A description of each follows:

A. Two joint meetings per year for all science clubs. Each club is to have equal representation on the program and all committee work.

(1) Our first combined meeting is held outdoors, soon after the fall opening

of school. This meeting is strictly informal and offers the opportunity for faculty and students to become acquainted. Old clothing is worn and such activities as soft ball, horseshoe, and quoit-pitching are organized. A committee prepares a "light lunch," which is followed by a social hour. This meeting is held after school hours and a definite date for our annual meeting is designated. Doubtless this is one of our most valuable club meetings for developing interest and good will.

(2) The other, a combined meeting, occurs in January. By that time the clubs are well organized and prepared to offer an abstract program. This meeting is held in the school cafeteria. Our administrators are the guests of honor. The lunch is followed by the program and a social hour.

B. In our second plan one club may invite another club to be its guest during a regular meeting. The guest club returns the courtesy.

C. In our third plan a club may wish to honor a student, not connected with the science department. The guest of honor may be a grid hero or any outstanding student which the club wishes to recognize. Our objective here is to develop good student attitude in the department.

II. Assembly Programs.

A. One assembly program per year to be the united effort of the department. The participants are drawn from chemistry, physics, and biology classes.

B. Individual classes or clubs arrange and present their own program to a school assembly.

III. Raising Money.

A. Food sale sponsored by department. While this is a meager way of earning money, it does offer an opportunity for cooperative action. Concerning the money, more will be said later.

B. Individual class or club food sales. Usually a worth-while objective can be established for earning money. An illustration of this may be given. Recently my biology club successfully conducted a food sale to secure the necessary funds to join the Student Science Clubs of America.

IV. Department Scrap Book.

This book is proving to be of considerable interest to our students. A good book was purchased and an appropriate title chosen. Only those faculty members and students who have actually accomplished something or have rendered valuable service to the department find their names in the book. For example—winning an award at the State Science Fair, publications, club pictures, merit through exhibit, winners of the medals we offer, outstanding photography, and newspaper clippings.

V. Increasing interest in physics and chemistry classes.

A recent survey of my students (biology) indicated many have almost no conception of the nature of chemistry and physics. Since they do not understand these courses, they fear them. One intelligent boy told me they sounded too dry and harsh. After a consultation with some of our better students and with the cooperation of the physics and chemistry teacher, we permitted the students to visit these classes during a regular period with the result that some of our better students are looking forward to pursuing these courses.

VI. State Science Fair.

Individuals and groups are encouraged to support this activity through participation.

VII. Night Science Meetings.

I have previously discussed in this manuscript, the various activities which have been functioning in the department for some time. Now I wish to direct attention to a part of our activity program, still in the organizing stage, which we anticipate putting into effect next year. I refer to night science meeting. The request for this program had its origin in our recent presentation of "Previews of Progress," which was presented through the courtesy of General Motors Corporation. Following this very impressive lecture and demonstration, many of our students requested that we continue bringing to the city outstanding science programs or recognized science specialists. Recently a meeting with faculty members and club officers in attendance was held to draft the plans. A brief summary of the results follow:

(1) Arrange for six meetings to be held at designated times.

(2) Invite a science specialist to be guest speaker at each meeting.

(3) Set up a budget to pay guest speakers.

(4) Develop means for earning money to meet the budget. One of the methods to be employed is the conduction of food sales to students.

(5) Type of Program selected.

(a) Student "A" Group discussion
(b) Student "B" Group discussion
(c) Department Faculty Group discussion
(d) Local citizen Group discussion
(e) Out of Town Science Specialist Group discussion

(6) The meetings to be open to all students doing science work in the ninth to twelfth grades inclusive.

(7) Invitations to attend will be extended to parents of the students.
(8) Students appearing on the program will be drawn from any class or grade.
(9) Over a period of years, we will attempt to place on the program specialists as follows: biology, chemistry, physics, agriculture, entomology, doctors, druggists, hospital heads, et cetera.

We believe, if our students are given the opportunity to follow such a program for a period of four years, it will prove an innovation to them. Undoubtedly this will be the only opportunity many will have to become affiliated with such activities. While there is some objection to night meetings, the program, by virtue of its nature, must be held at this time.

This program makes it possible for the students who do not plan to attend college or follow scientific careers to relate scientific achievements with modern everyday life functions.

It may be noted this program should broaden the students' associations and, as a result, they are less liable to be biased toward society.

Another feature of the program is to draw into closer contact the school and community. Certainly there is need for expansion here.

A MODEL LESSON IN GENERAL SCIENCE

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The success or failure in the teaching of any subject rests, to a large degree, in the ability of the teacher to make each lesson vitally interesting and worthwhile to the pupil. Sufficient experimental evidence indicates that if there is abundant present-day life activity in the classroom, the child is more likely to develop a lively interest in the subject studied. Success in the promotion of this type of lesson depends largely in the development of certain fundamental techniques in the learning process.

The chief purpose of this article, therefore, is to present some techniques which were employed in an "activity program" for a ninth-year general science lesson in a cosmopolitan high school of a metropolitan area. The group for this experiment was selective, pupils having grades of 80 per cent or higher. Thirty-two students, girls and boys about equally divided, constituted the teaching load. The length of this particular classroom period was sixty minutes.

The first task, then, in planning this lesson was to choose instructional material that was adapted to the age level of the pupils and at the same time lent itself readily to demonstration and purposeful activity. With this in mind the unit selected was machines and the specific aim of the lesson was to classify the three kinds of levers.

The second step included a search for a wide variety of up-to-date illustrative materials suitable to the lesson. With the aid of the school, library, and home, pupils and teacher collected unusual charts, diagrams, colored photographs, and an assortment of mechanical aids ranging from the tools of prehistoric man to the more modern appliances. Large working models of a simplified design were set up in an orderly fashion on the demonstration table. To arouse curiosity, these objects were covered with cheese cloth until ready for use.

Pupils talented in drawing made large colored posters and crayon pictures for all the walls. A girl with printing ability printed a set of well-planned introductory exercises on the front blackboard. Important words were underlined in yellow. A huge bouquet of flowers, arranged artistically by another girl, added much color to the "tone" of the room. To develop fur-

ther a wholesome teaching and learning situation, proper attention was given to lighting, heating, ventilation, sanitation, and the orderly arrangement of classroom materials.

For the first ten minutes the entire class was busily engaged working on the preview. During this time the teacher took care of all clerical matters and then gave personal supervision. Next, by raising his hand, the instructor signaled for attention, and then in a low voice called on different pupils to answer questions relative to the lesson. Informality prevailed throughout the recitation as pupils remained seated when reciting. Much enthusiasm was apparent by the continuous show of hands during this phase of the work.

After this short discussion the teacher uncovered a model of the "Queen Mary" built by two boys. From this complex machine the class discovered simple machines, such as levers.

Tools of primitive man with full-color illustrations were shown next by a girl who had an aptitude for history.

To avoid monotony and repetition in explaining the order of this classroom procedure, a lesson plan, together with an efficiency table,[1] accompanies this article. Practical applications were used throughout the lesson. Since it is impossible to list and discuss each one in this paper, only two examples have been selected. The first one worthy of comment was the comparison of the length of blades in the tailor's scissors with those of the tinner's shears. Another interesting application was the use of the force arm of a nut cracker as shown when the instructor cracked a walnut.

Perhaps one of the greatest values of an "activity program" of this sort is in the growth it provides for the teacher. He is often obliged to enter new fields of knowledge and interest in attempting to meet the pupils' needs. The classroom thus becomes a learning situation for everyone.

Needless to say, there are many teachers confronted with the problem of how to make their work attractive to the pupil. However, one must remember that no one single formula is applicable to every situation. The author invites inquiry or suggestions relative to classroom instruction.

[1] Used as a basis for discussion during a group conference following the lesson.

LESSON PLAN

Subject—General Science 9A
Date—May 12, 1938
Unit of Work—*"Machines"*

Major Problem: To identify the three classes of levers

Minor Problems

A. To build up a general conception of machines
Levers—(pp. 425, 426, 432, 433, 436-440, 610, 612—Figs. 211, 212, 213)

Preview

1. Define a machine.
2. Name three uses of machines.
3. Contrast a simple with a complex machine. Give an example of each.
4. What is a lever? Define the three classes of levers. Give an example of each.
5. Define fulcrum.

(pupils and teacher)

B. To learn some common levers of primitive times.
1. Oral report—tools and weapons of prehistoric man
(girl)
2. Oral report—mechanical inventions of Archimedes
(girl)

C. To classify levers from blackboard drawings
(boy)

D. To classify levers from models
(boy)

E. To recognize different class levers in class room, kitchen, garage, grocery store, etc.
(pupils and teacher)

F. To give tomorrow's assignment
Pulleys—(pp. 435, 436)
(teacher)

G. To discover advantages of levers
(boy)

H. To contrast a simple with a complex machine
Oral report—George Stephenson's locomotive
(girl)

I. To discover new appliances for the household
Oral report from *Popular Science Monthly*
(girl)

Summation

1. Completion of unit sheet
2. Observation of levers from colored pictures

Textual Materials

1. Class textbook—*The Science of Everyday Life* by Van Buskirk and Smith

Summation

Name..... Period..... Date.....

Problem: To classify levers

A Levers (Classroom)	First	Second	Third
1. Tailor's Scissors	X		
2. Grass Shears			
3. Drug Store Scales			
4. Paper Punch			
5. Baseball Bat			
6. Shovel			
7. Tinner's Shears			
8. Hanging Flower Pot			
9. Broom			
10. Hedge Shears			
11. Hand Plow			
12. Ice Tongs			
13. Fish Pole			
14 Crucible Tongs			
15. Jaws			
16. Lift Pump Handle			
17. Fire Tongs			
18 Tack Lifter			
19. Sugar Tongs			
20 Single Fixed Pulley			
21. Rubber Clamp			
22. Crowbar			
23. Test Tube Holder			
24. See-saw			
25. Door			
26. Pruning Shears			
27. Lemon Squeezer			
28. Scales			
29. Nut Cracker			
30. Balance			
31. Wheel Barrow			
32 Guillotine			

B. Classify Levers from Colored Posters

1.			
2.			
3.			
4.			
5.			
6.			
7.			

Criteria for Evaluating Teacher

	Excellent	Good	Fair	Poor
1. Pupils' interest in subject				
2. Physical conditions in room				
3. Attitude of pupils				
4. Pupil activity				
5. Definite teacher aim				
6. Responsiveness of pupils				
7. Attitude of teacher				
8. General attitude of teacher and pupils				
9. Atmosphere of classroom				
10. Skill in teaching technique				
11. Evidence of teacher preparation				
12. Method of instruction				
13. Assignment				
14. General appearance of room				
15. Evidence of pupil preparation				
16. Ability of teacher to "put across"				
17. Teacher and pupil cooperation				
18. Work going on				
19. Type of questions asked by teacher				
20. Discipline				

VITALIZING THE LABORATORY TO ENCOURAGE REFLECTIVE THINKING

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American educators have long held as an important objective, the ability and proclivity on the part of the student to think critically and reflectively through the many problem situations that life presents. Science teachers in particular have felt that their instruction was potentially capable of achieving this desirable outcome.

For many years subject matter of almost any nature was considered adequate in fulfilling the objective of reflective thinking. This was because of the belief that cogitation on any problem, however academic, was a logical disciplining of the mind and would result in an increased ability to analyze critically problems of any nature that might arise later in life.

The laboratory method was inaugurated during this period as a device admirably fitted to train the faculties. The laboratory manual was prepared with a firm conviction that its use would foster neatness and accuracy in all endeavors of life. Thoroughness in observation, critical deduction, and accuracy of work; all of these, it was felt, would be developed by the careful manipulation of apparatus and the meticulous observation of details which were required for the successful perusal of the science courses of that time.

By the time this belief in specific mental faculties had largely passed, much of science education had been standardized on this very viewpoint and continued through

its own inertia although its reason for existence was dead.

Beauchamp's [1] report on science courses in 1932, representing twenty-six states of the Union, indicated that much of the science instruction of that time held objectives not based upon general educational principles. Furthermore, the fact that 93 of the 160 courses studied were organized on topical bases which, in most cases, were quite detailed and factual, would imply that some belief in specific and discrete mental faculties still existed whether openly avowed or not.

The presumption seems fair that this retention resulted not from a continued conscious acceptance of the former fallacious theories of mental discipline and faculty psychology, but rather from a confusion as to how to change the subject matter and the instruction to fit the newer beliefs. All of the major studies of science instruction in the last twenty years have pointed science toward an interpretation of modern technological society and toward meeting the needs of the individual in that society, and away from the technics and subject matter of the formal discipline school.

The bulletin of the Commission on the Reorganization of Secondary Education,[2] appointed by the National Education Association, suggested the project method as one device calculated to further the development of reflective thinking. This method proposed to allow the student some measure of responsibility in instigating and carrying through experiments and studies designed to answer his own problems, rather than to ask him to carry out the exercises and experiments ordinarily included in the science course of study.

The report of the Science Committee of the National Society for the Study of Education [3] recommends that instruction in science be based upon "interpretative generalizations" which were large areas of human experience, rather than upon the laws and facts of pure science. The committee recommended further that the instruction be made meaningful and vital to the student by tackling problems and areas of experience with which the student in his particular time-place milieu was familiar and interested.

The report [4] of the Progressive Education Association's Commission on Secondary School Curriculum, Committee on the Function of Science in General Education, stressed teaching science "to meet the needs of adolescents in the basic aspects of living" and gave detailed analysis of methods to achieve this end.

In every one of the reports indicated, considerable emphasis was given to the development of reflective and critical thinking. *Science in General Education* devotes an entire chapter to the subject of "Teaching Science in Ways to Encourage Reflective Thinking" in which it states,

> The Committee believes that the ability to think reflectively and the disposition to do so in all the problem situations of life is an especially important educational objective. It is essential to adaptability, resourcefulness, and that type of self-criticism or 'stock taking' which leads to the continuing evaluation of personal beliefs and principles of action. The Committee also believes that science may be taught in ways to encourage reflective thinking." [5]

Thus the attainment of proficiency in reflective thinking through instruction in science is championed today as strongly as ever, but with a more critical regard to the psychology of the individual concerned. The desideratum of today's experiments in

[1] *Instruction in Science*, Monograph 22, Bulletin No. 17, 1932, U. S. Office of Education.

[2] *Reorganization of Science in Secondary Schools*, Bulletin 26, 1920, U. S. Bureau of Education.

[3] *Thirty-First Yearbook*, Part I, "A Program for Teaching Science." National Society for the Study of Education, 1932.

[4] *Science in General Education*. Report of the Committee on the Function of Science in General Education. D. Appleton-Century Co., 1938.

[5] *Ibid.*, p. 317.

science classes is not so much the development of factual knowledge as the encouragement of critical thinking in a situation which presents a real problem to the student. As stated in the Progressive Education Association Committee's report,[5]

> The value of problem-solving through laboratory work in the school does not lie in the factual knowledge that may result from it but in the attitudes and habits of reflective thinking it encourages and in the understanding it gives of how the knowledge of science gained by the student from description was attained in the first place.

Most of the experiments presented in present-day science manuals and carried out in science laboratory periods preclude the possibility of much reflective thinking on the part of the student. Too often the student's only job is to follow direction in an effort to achieve accuracy in results he already knows. Too often the subject of the experiment has little or no real interest and motivation for the student, who, as a consequence, blindly follows the directions without question or understanding. Under these circumstances it can hardly be expected that the student will develop resourcefulness and facility in employing the scientific method. As stated by the Progressive Education Association's Committee,[6]

> If he [the teacher] denies them [the students] the satisfaction of searching for the solution of a problem by providing them in advance with a solution that they might otherwise have reached for themselves, or if he is unsympathetic toward the mistakes they make in trying to think through problems for themselves, he may destroy their confidence and initiative and make them increasingly dependent upon authority.

But how are the science teachers to avoid such situations when practically all of the texts and manuals of science present experiments of this type?

The author has attempted the following solution. Convinced of the desirability of working on problems of the students, rather than those stated by the course of study, and further convinced that these problems must be solved by the student through his own experimentation and cogitation, he has avoided assigning specific days for laboratory work and has used the laboratory period as needed by the students for work on their own problems. Any fears that the laboratory would be unused through such a plan were soon dissipated. Any community presents more problems, meaningful and baffling to the student, than can be solved through participation in one year of work in science. I shall present two examples of experiments done in the classes of Concordia, Kansas, under this plan. One is from the field of chemistry and one from biology.

The chemistry class was engaged in the study of water sources and water purification. The community in which this class was situated draws its water from several deep shaft wells. Further purification of the water is unnecessary due to the filtering action of the sandy soil. Quite naturally the question arose, "How is the water supply of this community purified?" A trip to the pumping station and to the wells of the city answered this question satisfactorily but did not answer the question concerning the adequacy of the method. Several members of the class were former biology students and believed that a danger of water-borne diseases in epidemic proportions might exist in such a simple method of purification. Others coming from farms nearby were concerned about the purity of their drinking water and the desirability and possibility of purifying it further.

These problem attitudes, differing opinions, and rising interests in such problems of community importance might have "died a'borning" by simple arbitrary statements of the instructor concerning the adequacy of the methods involved in each case presented. But it was believed that these interests, if allowed to be pursued, would

[6] *Ibid.*, p. 314.

arouse social sensitivity and necessitate careful thinking on real community problems to a greater extent than would the vast majority of experiments offered in laboratory manuals.

Therefore, suggestions as to plans of procedure were called for and a line of attack was drawn. Some of the students who had previously taken biology suggested the advisability of testing for *B. Coli* through the use of fermentation tubes, and of making bacterial counts on petri dishes. These students were given the responsibility for this phase of the investigation. Much had to be relearned and some things had to be ferreted out for the first time. Help was secured from members of the biology classes at some points. And, although the instructor assisted at all points of the investigation, the responsibility and the major amount of the experimentation was carried out by the students.

The instructor prepared a set of mimeographed outlines of chemical analysis of water for nitrates, nitrites, hydrogen sulphide, organic ash, and sodium chloride. These outlines were used by the entire class during the two-week period of investigation. The ordinary classwork was suspended completely while this investigation was under way. Not only were biological and chemical analyses made of the city water supply, but also of well water from many sources, water from the school swimming pool, water from the nearby river, and water from various ponds and cisterns near and in the city.

It is not claimed that the answers thus obtained were by any means of the highest accuracy. Neither is it claimed that the methods employed were of the latest and the most highly accurate type. But it is clear that the students were working with enthusiasm and care on a problem that interested them greatly. Furthermore, this problem was one which was raised by the students and had meaning for them. It was one which was of great importance to the community and was recognized as such by the students. The resolution of the problem required careful and critical thinking and sifting of procedures to insure the use of the correct ones. And the results were meaningless without clear analyses of the possible inferences to be drawn and the selection of those conclusions most in keeping with the ascertained facts. Each sample of water was chemically analyzed by two groups of students working independently so that the results could be checked. Their results were further compared with the results obtained by those students analyzing the water bactriologically. Close agreement was not secured in every instance. But in general the results checked surprisingly well. More important educationally, these students were not checking textbook and manual statements of fact. They were engaged in answering a real problem by the best scientific methods they could discover. They were using the laboratory as a scientist uses his laboratory, that is, to answer questions unanswerable in any other manner. And during those two weeks of activity there developed an appreciation of the analytical chemist, his work, his difficulties, and his value to society.

An example of this type of laboratory work in biology concerns a class in the same community and its routing of certain common superstitions. If the ordinary "garden" variety of superstitions represented the only gullibilities of the student there would be little point, educationally, in touching upon them at all. But it would appear that a mind, which will accept without question and investigation such superstitions as those concerning the glass snake, the black cat, and Friday the thirteenth, is one that may be credulous of every "ism," advertising claim, and doctrine of any type, presented. And one path toward critical thinking and evaluating different points of view is through the analysis of cause and effect relationships in such

simple materials as are offered by these superstitions. *Science in General Education*[7] presents the following statement on this matter:

> Superstitions, the outmoded folkways with which a changing society must always contend, and the propaganda and special pleading of individuals and groups with special interests constitute the chief external obstacles to reflective thinking. The science teacher can help students to discard superstitions and folkways that have lost their usefulness in part through guiding their study of particular ones.

How shall the science teacher help students to eradicate such misbeliefs? By assertive methods? Try telling a class that the hoop snake story is a myth and that the glass snake is really a legless lizard which can whip off its tail but cannot break into a dozen pieces and reassemble its parts at will. Many will believe you for the story has never been told to them by one in whom they had faith. But in every class you will find some whose grandad or dad or sister or brother has actually "seen" these remarkable phenomena occur. And for these students, whose credulity you are particularly anxious to dispel, your ridicule will rankle but hardly convince. For you may be setting yourself up as an arbitrary authority in opposition to that highest of authorities, the child's father. Besides, your function is not merely to state the truth in these matters which in themselves are innocuous. Your purpose is to aid the child in developing the proclivity and the ability to analyze objectively all of his beliefs and those of others which are offered to him. If possible we want to develop critical evaluation of all propaganda, including our own.

How, then, shall we attack the glass snake story? It may be done in this manner. Sufficient preserved snakes are obtained for each group of five students to have one for dissection. When the inevitable glass snake story came up it was suggested that the prevalence of the belief would appear to make it worth our time to investigate it rather thoroughly. First, a complete recounting of the stories, by the class members who had heard them, was called for. Not only did we secure these stories but we noted the range of embellishment the stories possessed.

Immediately, of course, there was opposition to the stories from a number of students who "pooh-poohed" the whole idea. Rather than taking sides in the argument it was recalled to the students that we had, all during the course, been attempting to discover what authority on any subject really amounted to, and that we had concluded that even the authorities often vary in their opinions. We had decided that the intelligent action was to secure as much authoritative information on any problem as possible, from as varied sources as possible, and upon such a basis, coupled with the results of any investigations we could make, to decide for ourselves what conclusions appeared to be in keeping with the facts. "Why not," it was suggested, "apply what we have learned to the problem at hand?"

Many sources for information were suggested. Students volunteered to investigate these sources for expert opinion on the subject. Many in the class were surprised when I asserted that I had two preserved specimens of the glass snake in the stock room, for they not only had disbelieved the stories concerning the glass snake but had presumed that the animal itself was non-existent. Comparison of the lizards with photographs in such books as Ditmar's book on reptiles indicated that the animals were the ones in question.

Each member of the class was allowed to examine the reptile and we discussed the probability of the animal being able to tear himself apart and then to rejoin these parts. Someone suggested that the internal organs might be jointed in some way. Without more ado we cut open one of the reptiles so that all might examine the viscera. An X-ray of a snake was shown,

[7] *Ibid.*, p. 315.

indicating the vertebral column. Finally it was suggested that the students might like to dissect snakes themselves and thus obtain help in answering the question.

The zest with which the students tackled the dissections was, as might be imagined, considerably greater than that with which they had dissected earthworms sometime previously. Prescribed outlines for dissection were not given. It was pointed out that the snake was perhaps one of the most maligned and misunderstood animals existing. And it was suggested that they take the time to examine the animal carefully in order to answer the many questions which had undoubtedly occurred to them concerning the snake, his life and habits. Some of the snakes were found to be viviparous and full of young in yolk cases. Others were found to be oviparous and careful comparisons were made. Most of the students were surprised and intensely interested to find such modifications as that of the single lung rather than two. Many students were interested in the size and the arrangement of teeth in these non-poisonous snakes.

Finally, through an examination of the various systems and organs of the body, as well as from the examination of the organs of the glass snake itself, every student appeared to be convinced that the snake could not, "without black magic" as someone suggested, tear himself apart, let alone reassemble the severed members. The study was followed by reports of the students who had studied encyclopedias, texts, and so forth, and was consummated with the superstition apparently well "laid." More important, I believe that the students had experienced excellent training in scientific methods of investigation, open attitudes, and tolerance, and had acquired many interesting facts and concepts concerning reptilian life.

Many examples of this type of laboratory work could be presented. Diet experimentation with rats,[8] breeding experiments, mammalian dissection and comparison of the intestinal tracts of different orders in relation to their food habits, vivisection of mammals to illustrate heart beat, peristalsis and other bodily functions, are all worth while. But the two examples given will perhaps suffice to illustrate one point of view toward vitalizing the laboratory.

For it is the author's conviction that we must beat the manuals to the draw if we want our laboratory work to promote reflective thinking. We need not let the manuals give students the answers before they actually start the experimentation. We can conduct photosynthesis and wheatstone bridge experiments before the manuals present them. We can develop experiments of our own. And we can do it all in terms of student interests and needs. We can let the entire laboratory program develop out of student problems that have community reference and that have developed in the classroom. If we do this, our science classes may more nearly achieve the results that we have established as worthy of attainment.

[8] "Diet experimentation as a Student Project in the High School Biology Department," R. Will Burnett. *School Science and Mathematics*, March, 1938.

A NEW SCIENCE PROGRAM IN THE MAKING

IRA C. DAVIS

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The president of a publishing concern asked me this question a few years ago, "Do you know how we rank school teachers and administrators?" Being curious, I said I would like to know. Then he answered his own question by saying, "We rank school teachers and administrators as ninety per cent talkers and ten per cent doers." I did not argue the question with him, but I thought possibly a little self-examination would do no harm.

After I have attended several conventions each year, I wonder how far we do get beyond the talking stage. I am not insinuating in the least that the talking is unnecessary or that it does interfere with progress in education. This question has been raised in my mind several times the past few years, Does our present set-up of teacher organizations provide a democratic procedure for solving the many perplexing problems we have in science education today? No doubt all organizations are making some contributions to the solution of these problems. However, isn't there a great amount of duplication and lost motion? All organizations have about the same kind of programs at conventions. Quite often the same topics are discussed in several conventions in one year. If you study the convention programs of several organizations over a period of years, you will discover that series of topics seem to run in cycles. I heard an elementary science teacher say not long ago, "I have attended six conventions the last two years and all of them have had practically the same program."

I realize full well the social and educational advantages that come from learning to know a large number of science teachers. I value these friendships a great deal. But friendships and programs do not necessarily get us beyond the talking stage in education, and I believe if you visited a large number of classroom teachers in action, you could place most of them in two groups: those who teach and those who talk about teaching. But everywhere you hear teachers say they are becoming impatient. One day, they hear this is the right way to teach. Then the next day, someone else tells them that method is outmoded and probably never was right in the first place. But can we blame them for being impatient and hesitant to tackle new problems? Where could a group of science teachers go today to get help on science teaching and science education? I mean help based on the carefully thought out plans of a large number of good teachers, plans developed through a careful and comprehensive study of the whole field of science education. Some of you, no doubt, will say, "Are you not criticizing the good work that has been done by a large number of individuals and small groups?" I have only praise for these good teachers who have laboriously conducted worthwhile investigations. The reports and books issued by them have caused people to think. These materials have caused teachers to question what they were doing. But they still leave us in the talking stage.

Isn't there some way we can make use of all the good talking we have been doing for years and proceed into the doing stage? By the doing stage I mean a program which is really reaching our boys and girls in every science classroom. Isn't it possible for us to construct a program in science education that will really function in all of our schools, both large and small?

But you, no doubt, will say, "Who should do it?" My answer is, All of us should do it. This means classroom teachers and administrators at all school levels.

Some kind of an organization needs to be perfected for the undertaking of such a program. This organization must have enough educational support to give 'drive' to its program when it is formulated. The program must be promoted by an organization, or organizations, in which teachers have confidence and respect. I have felt for some time that we did not have any one organization that could undertake such a program alone. The main obstacle is finances. I doubt if there is one elementary or secondary school science teachers' association in the United States that can really afford to pay the expenses of one representative to the meetings of a committee for a period of two years. This is not a criticism of any of these organizations. They really have no possible ways of raising enough money to undertake such a program. Most of the money they do get is needed to take care of overhead expenses.

What organization is in a position to initiate such a program? I doubt that any of you will disagree with me when I say I believe the National Education Association should undertake such a program. The Association has approximately 200,000 members, is well-financed, and has a forward-looking program in the making. Two years ago the Department of Science Instruction discussed the desirability of requesting the budget committee of the N.E.A. for funds to undertake this program. The Executive Committee and the general assembly approved the request at the meetings in New York last June. Mr. Givens, executive secretary of the Association, and Mr. Shaw, the president of the Association, and a science teacher, have given every possible help in getting the program under way.

The Department of Science Instruction invited all national organizations of science teachers to cooperate in developing such a program. In order to get organizations of proven stability, it was decided to limit the invitations to organizations which had had a continuous existence for at least five years. All district, local, and group organizations have been invited to select consultants to assist with general and special problems. The consultants are invited to attend meetings when it is possible for them to do so. It is hoped the consultants will be able to do at least two things: first, furnish the general committee with information and facts on science teaching in their organizations or districts; and second, consider and discuss with their organizations and groups the problems submitted to them by the general committee. At present 72 consultants have accepted the invitation to cooperate with the general committee. When the list is completed the total number should exceed 200. It should be understood that one consultant represents a large number of teachers.

The following national organizations are cooperating and have selected these representatives for the General Committee:

American Association for the Advancement of Science
Nathan A. Neal, Rhodes High School, Cleveland, Ohio
H. A. Webb, Peabody College, Nashville, Tennessee

American Nature Study Society
Carroll Lane Fenton, Washington, D. C.

American Science Teachers Association
Harry A. Carpenter, West High School, Rochester, New York

American Chemical Society—Chemical Education Section
M. V. McGill, Lorain High School, Lorain, Ohio

Central Association of Science and Mathematics Teachers
Harold H. Metcalf, Oak Park-River Forest Township High School, Oak Park, Illinois

National Association For Research in Science Teaching
E. S. Obourn, John Burroughs School, Clayton, Missouri

National Council on Elementary Science
Florence G. Billig, Wayne University, Detroit, Michigan

Department of Science Instruction of the N.E.A.
W. C. Croxton, St. Cloud State Teachers College, St. Cloud, Minnesota
Mrs. Gladys F. Potter, State Department of Education, Sacramento, California
S. R. Powers, Teachers College, Columbia University, New York
C. E. Preston, University of North Carolina, Chapel Hill, North Carolina
W. R. Teeters, Board of Education, St. Louis, Missouri
Ira C. Davis, Chairman, University High School, Madison, Wisconsin

This committee will direct the general plans for developing the program and will be assisted by a large number of very able consultants.

Several factors were taken into consideration in selecting members for the committee. Following are some of the factors:

1. Breadth of experience in the teaching of science.
2. Standing in the field of science education or education in general including the publications written.
3. Number of teachers to be reached for discussions and reactions. Organizations to be contacted.
4. Secretarial help available.
5. Freedom to attend committee meetings on school time without loss of pay to the member or an expense item to any organization.
6. Distribution both geographically and for the different school levels. Members come from ten different states and the District of Columbia.

The same general care has been taken in selecting the consultants. Practically every organization of science teachers in the United States is represented by a member of the general committee or by a consultant. The total number of consultants is 72. The total number of states represented so far is 40.

The committee held its first meeting at Cleveland on February 23 and 24. The two-day meeting was largely devoted to a discussion of problems in the field of science education. Dr. Palmer of Cornell University discussed problems of conservation; Dr. Teschler of the American Medical Association problems of health; and Dr. Helen M. Strong of Washington, D. C., and Dr. C. Langdon White of Western Reserve University, problems in the fields of geology and geography. W. E. Givens and Reuben T. Shaw discussed the future plans of the Educational Policies Commission.

The committee's problem is to develop a program in science for grades one to fourteen, inclusive. It agreed to a five-point attack on the problem. Sub-committees were selected to make a thorough study of science education through these five points.

Sub-committee on Philosophy or Frame of Reference
Nathan A. Neal, Chairman, Harold H. Metcalf, H. A. Webb

Sub-committee on Present Day Needs of Boys and Girls
W. C. Croxton, Chairman, Florence G. Billig, Harry A. Carpenter

Sub-committee on Evaluation of Methods and Results of Teaching
C. E. Preston, Chairman, M. V. McGill, E. S. Obourn, W. R. Teeters

Sub-committee on Teacher Education
S. R. Powers, Chairman, Florence G. Billig, Gladys F. Potter

Sub-committee on Administration
Ira C. Davis, Chairman, Gladys F. Potter

Each consultant has been assigned to one of these sub-committees. This means that each sub-committee has a good representation of science teachers for all school levels, for all subjects in science, and for all parts of the United States.

The members of the general committee and the consultants extend a most cordial invitation to all teachers of science to cooperate in making this new science program. This new program will not be any better than teachers make it. It will not be any better than teachers can teach it in the classroom.

If you are interested in cooperating, please send your name to the writer or to any chairman of a sub-committee.

THE DEVELOPMENT OF A PHYSICAL SCIENCE COURSE FOR THE LINCOLN SCHOOL

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Ideally the only claim that science, or any other subject, has to a place in the modern secondary curriculum should derive from the quality of its presumptive contribution to an education which can be shown to be desirable both from the point-of-view of the individual and of society. Stated negatively, neither science nor any other subject has just claim to a place in the curriculum solely on the grounds of prestige or its present privileged position. And yet the present article does attempt to set forth a course in science for the last two years of the secondary school.[1] In light of the above position it is obvious that prior to the actual writing of course materials certain preliminary steps needed to be taken. The work on this project may be seen as falling into three stages: These are:

1. to make a statement of what seems to be a justifiable philosophy of education, along with the kind of education it implies;
2. to examine the fields of science to see what potentialities their subject-matter possesses for furthering the aims and objectives of this education;
3. to set up a science course for the 11th and 12th year of the Lincoln School, designed to be the best compromise between what might be considered ideal, and the factors in the actual situation that force a deviation therefrom.[2]

THE PHILOSOPHICAL POSITION

The philosophy which has operated in this situation is substantially that set forth in a report of the science committee of which the writer has been a member.[3] The committee aligns itself with that group who believe that the function of education on the secondary level should be general, rather than narrowly specialized or vocationalized, when it says (p. 23), "The purpose of general education is to meet the needs of individuals in the basic aspects of living, in such a way as to promote the fullest possible realization of personal potentialities, and the most effective participation in a democratic society." This statement is so very general in nature as to require elaboration and explanation.

The expression "general education" has come to have a rather special meaning over and above what is conveyed by the juxtaposition of the two words. Statements about general education are more likely to deal with what it may do for the student rather than with the rather vague entity which is the referent for the expression. Thus we read that "the function of general education is to contribute in every possible way to the growth of rich and many-sided personalities. This requires, among others, educational experiences which will bring the individual into contact with the culture which is his birthright, in such fasion as to widen and deepen his comprehension of his own nature and of his relation to the physical universe and to the life of the past, the present, and the future. All his educational experiences should aid in the development of those attributes now most needed if the individual is to play effec-

[1] The present article is a condensation of a much longer study submitted in partial fulfillment of the requirements for the Ed.D. degree at Teachers College, Columbia University.

[2] The fact that a *physical-science* course, rather than one in *science* as a whole is planned, partakes of both ideal and compromise characters.

[3] Thayer, V. T., and Others. *Science in General Education.* D. Appleton-Century Co., New York, 1938.

tively his personal role in the drama of cultural continuance and cultural change."[4] Elsewhere in the same report, this committee remarks significantly that "it is of the utmost importance to recognize that what is now seen primarily to be needed is not a different type of education for the less 'academic-minded,' but rather a new and improved general education for all." Edmund E. Day,[5] then Director of the General Education Board, states that the ultimate responsibilities of general education are social in nature, and of two kinds—those directed towards maintenance of social solidarity and stability and those designed to promote social differentiation and change. This means that "through general education, students are expected to acquire knowledge of the physical universe, the social order, and the cultural heritage" (page 17). Although he does not use the term, Bagley[6] probably had at least one aspect of general education in mind when he said ". . . the fundamental function of organized, formal education is to see to it that the most significant learnings of the race are woven into the life experience of each generation. In selecting these learnings . . . the welfare and progress of society must be the fundamental criterion." General education then seems to cut two ways. It professes as its ideal the training of individuals who, while not superficially educated, nevertheless exhibit such a broad development of intellect, esthetic appreciations, desirable emotionalized attitudes, mental and bodily vigor, and specific skills and abilities as to be free from the narrownesses that too often characterize the products of specialized or vocational training. This does not mean, of course, that general education rejects the right of the individual to follow specialized or vocational interests. In addition, general education believes that all this training of the individual shall go on within the framework of our democratic society, with the idea of training citizens who at once understand, and are willing and competent to perform, their duties as members of that society. Further clarification of the meaning of general education will come with the application of this concept of education in the elaboration of the latter part of the statement previously quoted from the science committee's report.[7] To this then we turn.

In attempting to see the relationship between the various elements that enter into determining the curriculum in science, the writer attempted a diagrammatic representation. After passing through several revisions it took the form of figure 1. Though titled "Elements in Determining the Science Curriculum" the sources of the curriculum which are therein related may have equal validity for the curriculum in general. For that, however, no claim is made. A second point needs to be made before explaining the diagram. Although based upon the report previously referred to[8] the relationships indicated in the diagram do not necessarily represent the point-of-view of the entire committee since the present writer, alone, is responsible for the diagram. In working out the scheme of representation it seemed advisable to make certain departures from the phraseology and usage of the report. These changes will be described in their proper place in the ensuing discussion.

In consonance with the position taken with respect to general education, the chart indicates that the fundamental source of the curriculum is the *complex* "The Individual in his Basic Aspects of Living." To the committee already referred to, these

[4] Unpublished (mimeographed) report of "A Committee Appointed to Consider a Projected Proposal for an Enlarged Program for General Education." Teachers College, Columbia University, March 31, 1937.

[5] Day, Edmund E. "Basic Responsibilities of General Education." *Educational Record* 17 (supp. No. 10) : 8–22; October, 1936.

[6] Bagley, W. C. *Education and the Emergent Man*. Nelson, New York, 1934, p. 210.

[7] Thayer, V. T., and Others. *Op. cit.*, p. 23.

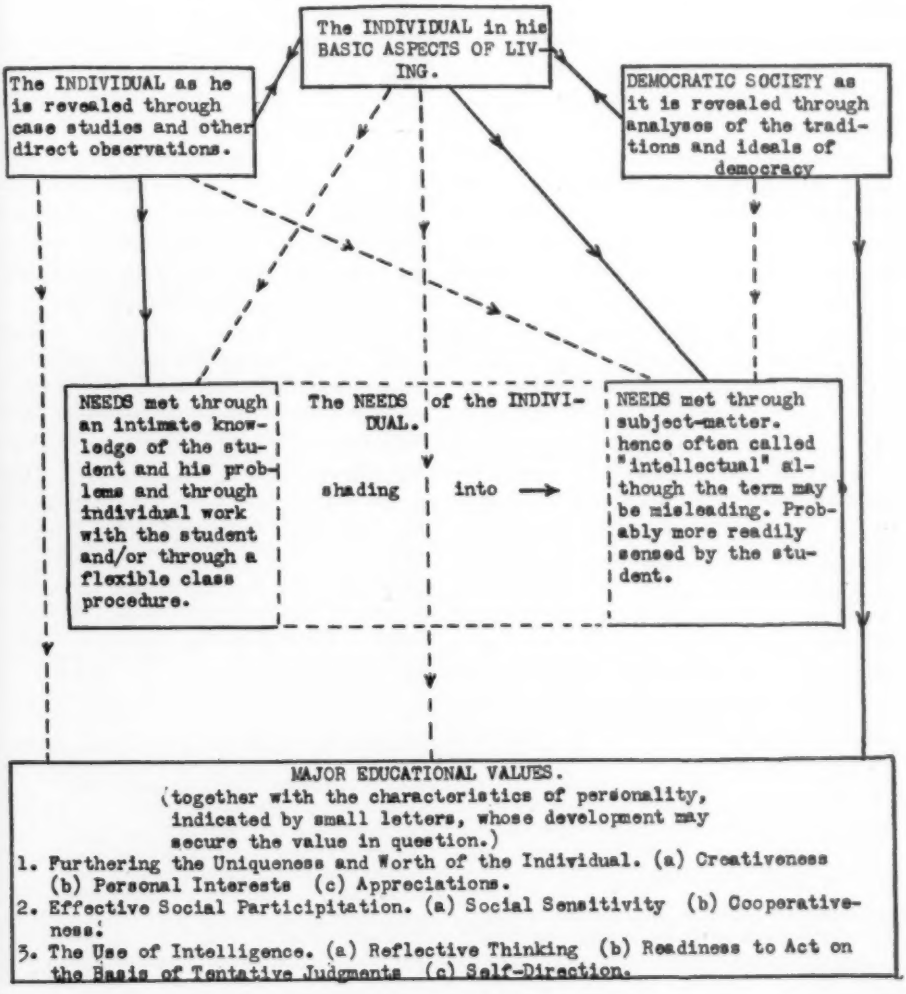
[8] Thayer, V. T., and Others. *Op. cit.*

mean the "involvements of youth" and, in the final report, are four in number: Personal Living, Immediate Personal-Social Relationships, Social-Civic Relationships, Economic Relationships.

Although this *complex* of the Individual in his Basic Aspects of Living is a unity, nevertheless we may consider the *Individual* apart from it, largely without reference to *Society*, for the purpose of analysis. The

FIGURE 1

ELEMENTS IN DETERMINING THE SCIENCE CURRICULUM


The INDIVIDUAL in his BASIC ASPECTS OF LIVING.
The INDIVIDUAL as he is revealed through case studies and other direct observations.
DEMOCRATIC SOCIETY as it is revealed through analyses of the traditions and ideals of democracy
NEEDS met through an intimate knowledge of the student and his problems and through individual work with the student and/or through a flexible class procedure.
The NEEDS of the INDIVIDUAL.
shading into
NEEDS met through subject-matter. hence often called "intellectual" although the term may be misleading. Probably more readily sensed by the student.
MAJOR EDUCATIONAL VALUES.
(together with the characteristics of personality, indicated by small letters, whose development may secure the value in question.)
1. Furthering the Uniqueness and Worth of the Individual. (a) Creativeness (b) Personal Interests (c) Appreciations.
2. Effective Social Participitation. (a) Social Sensitivity (b) Cooperativeness.
3. The Use of Intelligence. (a) Reflective Thinking (b) Readiness to Act on the Basis of Tentative Judgments (c) Self-Direction.

Note: 1. The size of the box is not to be taken to indicate the relative importance of the element.
2. Arrows indicate relations between elements.
3. Solid lines indicate what are believed to be the more important, direct relations; dotted lines the less important, less direct relations.

science committee had access, through its members and through specialists called for consultation, to the results of a large variety of case studies and other direct observations. (See upper left box.) The writer feels that analyses of these studies may contribute to an understanding of the *Individual in Society*. Accordingly the line from the Individual to the central box has arrows pointing in both directions. A similar dual relationship was felt to exist between "The Individual in his Basic Aspects of Living" and "Democratic Society." However the study of the individual, alone, is more valuable in the uncovering of those needs which are of such a character that the teacher must meet them through the sympathetic treatment of the child rather than through the subject-matter of instruction. These needs include the need for security, the need for affection, the need for self-assurance and others.

Referring to the center of the diagram, it will be seen that the "Needs of the Individual" are conceived as being arranged on a sort of scale, ranging from those which are met through individual work with the student, or through a flexible class procedure, or through both, to those needs met, or capable of being met, through subject-matter. It will be noted that it is probable that needs at the left of the scale are determined most completely from a study of "The Individual," from the *complex* "The Individual in his Basic Aspects of Living" in smaller degree, and from "Democratic Society" in negligible degree. Those needs at the right of the scale (*i.e.*, those capable of being met through subject-matter) are determined most completely from a consideration of the *complex*, as indicated on the diagram, and in smaller degree from the other sources.[9]

Theoretically, as one of the members of the committee pointed out,[10] it might be possible to determine all of the desirable outcomes of instruction by a study of adolescent behavior alone. In practice, it is probably not possible so to do. Hence there is included a list of "Major Educational Values" which, since they are "philosophical concepts derived from a synthesis of race experience and the kind of society we want" [11] are derived from analyses of all three of the sources indicated at the top of Figure 1. The fact that, there included, are three types of Educational Values [12] is not to be interpreted to mean that they were obtained one from each of the three sources. The solid line drawn from "Democratic Society" indicates the putatively greater contribution of this source to knowledge of the Educational Values.

THE SELECTION AND ORGANIZATION OF SUBJECT MATTER

In line with the position taken above, it is believed that the only subject-matter from the field of science that has worth is that which contributes to the needs of the individual in his basic aspects of living. That subject-matter so chosen may also meet the needs of the individual insofar as they may be considered apart from relationships, and from the claims of democratic society, is not obvious, but such is believed to be generally the case. Certain special needs may be met through the way the teaching units are set up—a procedure

[9] A list of Needs and Values, derived from the report, and used by the writer in formulating units is given in a later section of the present article.

[10] Alberty, H. B. *Some Reflections on Needs and Values.* Unpublished memorandum circulated to committee members under date Nov. 23, 1936.

[11] Alberty, H. B. *Op. cit.*

[12] In the most recent, and final, report of the science committee referred to in footnote 3, the term "Educational Values" is not used. What was formerly included under that head is now listed in the section titled "The Major Ideals of Democracy." Neither is the division of the Values into three parts as shown at the bottom of figure 1 retained. Because of what he believes to be certain advantages that accrue from the use of these terms in curriculum construction, the present writer decided to retain the earlier terminology.

to be described in the last portion of this article.

To the question of how to set forth the subject-matter ideas, chosen in accordance with the above criterion, the report of a committee headed by S. R. Powers [13] gave the answer. This yearbook having taken the general position that the aim of education is "Life Enrichment through Participation in a Democratic Social Order" (page 42) states that "The major generalizations (of science) and associated scientific attitudes are seen as of such importance that understandings of them are made the objectives of science teaching" (page 44), and later on the same page "Principles and generalizations of science are objectives." Without pausing to consider how this position may differ from that of the P.E.A. science committee, we may accept as did they, the method of setting forth these principles or generalizations in declarative sentences, as a means for suggesting science subject-matter. These statements define, not sentences to be memorized, but rather goals toward the attainment of an understanding of which instructional activities are directed. Quite evidently, statements such as the very simple "The earth seems very old when its age is measured in ordinary units of time" (31st Yearbook, p. 48) can be used to organize, or suggest, learning experiences at a variety of grade levels, and suggests an understanding which can be appreciationally enlarged throughout the span of one's entire life. The present science committee, while attempting to broaden and restate the objectives of science instruction, accepted this method of indicating the science curriculum, adding to the science generalizations another category of statements, the *inquiries,* which are used to suggest content in an area in which the evidence is conflicting, or subject to more than one interpretation.[14] Accordingly, in each of the chapters dealing with the basic aspects of living, organized under the needs of adolescents in that area, there appear statements of generalizations and inquiries which define the science content believed to be appropriate to the meeting of these needs. These statements suggest subject-matter which is believed to be valid and which the present writer was accorded the privilege to use in setting up his own science course.

Almost immediately the necessity for seeing the relationships between the statements was apparent. Valuable as was their organization under needs for purposes of exploration, such an organization did not seem to offer suitable centers for organizing teaching units. The authors of a certain series of general science texts [15] had used a large *chart* to set forth the science principles and generalizations presented in their books. These statements were organized under a number of interpretative generalizations, one for each of a number of columns. Each column was divided horizontally according to the theme of the year in which the statement fell. Such a chart seemed likely to be of value here. One important difference existed between the use in this project, and the use of the general science chart. The latter was designed to show the relationships between ideas presented in books already in existence. The chart, here, was to serve as a sort of reservoir of ideas from which the materials for science units was to be taken. Furthermore, since these units were to be for a

[13] Powers, S. R., and Others. *A Program for Teaching Science.* 31st Yearbook, Part I, of the National Society for the Study of Education. Public School Publishing Co., Bloomington, Ill., 1932.

[14] The fact that some of the statements used to indicate the content of the science curriculum are in the form of declarative sentences while others are in question form, carries no significance with respect to the method of instruction. The problem approach would probably be used with both.

[15] Powers, Neuner, and Bruner. *A Survey of Science.* Ginn & Co., New York, 1934.

physical science course (rather than for a science course which might encompass portions of any or all science fields) a considerable number of the statements would not be used in units. Hence the horizontal organization into years, or themes suitable for a year's work, was rejected, and the statements were simply organized under a number of vertical columns, each headed by an interpretative generalization.

In the chart as finally worked out there were nine such columns, the interpretative generalizations for which appear at the end of this paragraph. There is nothing necromantic in the number, *nine*. It merely represents what seems to be a reasonable number of generalizations under which to organize materials. These generalizations are similar to those used by the Bureau of Educational Research in Science.[16] Since they were intended for use by the writer to reveal relationships and suggest organizations, it was felt that the number of these generalizations and their nature, was largely a personal matter. The statements should, of course, be at once accurate and sufficiently broad. To check on these points a number of books, written by scientists of standing, and designed for consumption by the educated layman were examined. These books included representatives from each of the fields of biology, geology, astronomy, chemistry, and physics, as well as survey books, such as the University of Chicago's "Nature of the World and of Man."

The Interpretative Generalizations

1. The earth is only a small part of the universe. Evolutionary process which produces organization of stellar material is characteristic of the universe.
2. Due to the action of natural forces, the surface of the earth has undergone and continues to undergo change. Present environmental conditions may be seen as products of this action.
3. Living things are interdependent and there is a continuous interaction between living things and the environment.
4. Energy may be transferred in the form of electromagnetic waves, called radiation, of various types. Energy from the sun reaches the earth in the form of radiation. Direct absorption produces many effects of importance to man. Man has gained an increasing knowledge about and control over the various energy transformations.
5. There is a continuous flow of matter and energy through all living things in the normal processes of growth, development, and maintenance.
6. Various types of evidence indicate that plants and animals have had a continuous development through the ages from the simplest to the most complex forms.
7. Properties of matter and its behavior during chemical and physical change may be explained in terms of molecular and atomic theories of the structure of matter.
8. The development of natural resources and the production of materials is at once basic to modern civilization and a factor in determining the character of that civilization.
9. The human mind seeks to discover and to coordinate ideas and to discover the correspondence between ideas and the external world. These processes and their results have had a profound effect upon man's cultural life.

The statements that occur under these nine headings were taken largely from the science committee report.[17] One important difference should be noted. Earlier editions of the report had included two Aspects of Living which do not appear in the final report. These two, Cultural Life, and the Natural Environment, have been eliminated and such of the generalizations and inquiries, formerly included under them, as seemed valuable were listed in the other aspects. Several members of the committee, including the writer, while willing to experiment with organization in this fashion, felt that although so to do would undoubtedly eliminate much "dead-wood" from the science curriculum, it might also eliminate some that is of value. Consequently, the chart as it finally appears, contains a number of statements that the

[16] The Bureau of Educational Research in Science, Teachers College, Columbia University. In its exploration of the "archives of science" this bureau is using six of such organization centers.

[17] Thayer, V. T., and Others. *Op. cit.*

writer felt were thus eliminated. Similarly some of the statements from the science committee's latest report were not included in the chart when it was felt that they were repetitious of statements found elsewhere, or suggested content which did not seem suitable in the Lincoln School situation. Certain statements also were added as the result of the preparation of the themes discussed in the next paragraph.

The chart completed, a theme dealing with the ideas found under each of the interpretative generalizations was written. These themes were undertaken with three ideas in mind: (1) to show relationships more clearly than they were evident in the chart, (2) to broaden the writer's knowledge in the nine areas, some of which, at least, were outside the field of his specialization, (3) to assist in the preparation of units. As the result of the attainment of the first two of the purposes, certain rearrangements of the statements in the chart were effected and, as has been stated previously, certain statements were added. The third function of the themes was realized in two ways. Along with the chart, they constituted a reservoir of ideas on which to draw for the content of units, and secondly, the description of units could sometimes be shortened by using portions of themes in the unit descriptions, or by making reference to them.

THE APPLICATION OF THE PHILOSOPHY TO CURRICULUM CONSTRUCTION

A really practical application of a philosophy cannot be made without reference to the school situation in which it must operate. Consequently it seemed desirable to present those aspects of the Lincoln School situation that seem to have relevancy. Of these there seemed to be nine that are of importance. They are:

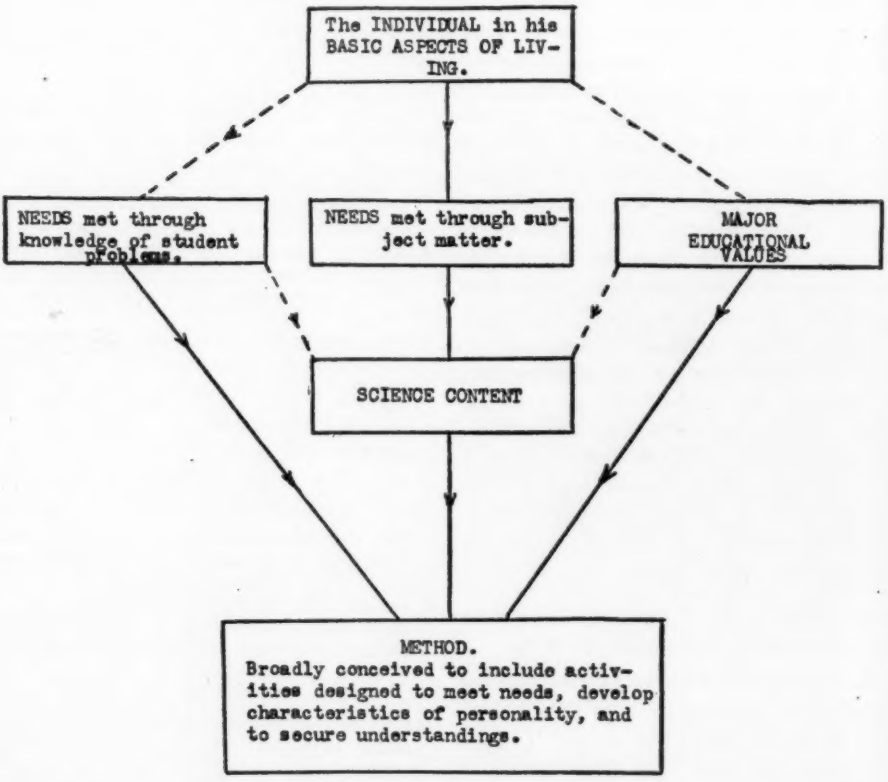
1. The Lincoln School is an experimental school, operated by Teachers College.
2. The enrollment in the senior high school, for which this course is intended is small—about 150. This smallness makes it impossible, at least at present, to offer second level courses in the physical sciences in addition to the two-year sequence.
3. The size of the science staff (three for both senior and junior high school) and the character of the training of these persons would probably necessitate the offering of separate courses in the biological and physical sciences. Although this is true, certain other considerations lead the writer to believe that the offering of separate courses (but not the rigid compartmentalization of work) in these two areas, is desirable in any case. Of that more anon, however.
4. The level of student ability in the Lincoln School is high. It is not the policy of the school consciously to strive for this condition of affairs, but certain selective factors, inherent in the situation operate to bring it about.
5. Students in the Lincoln School are used to carrying out a great deal of their work on an independent basis. They are, as a rule, well versed in the techniques of library research. They are willing, and rather expect, to have a share in the planning of the work in a given course.
6. Most of the Lincoln School graduates go to college, although a considerably smaller percentage of graduates will become specialists in science.
7. The curriculum of the senior high school is undergoing revision. Experimental courses, in which science teachers cooperate with teachers of other subjects have been, and are being given with various effects upon the "regular" subjects.
8. The school is one of the group of schools, scattered throughout the United States, which for a period of years are to be free from college entrance regulations (except for a few non-participating colleges) as part of the so-called "Thirty-School Experiment."
9. As one of the first of the progressive schools, the Lincoln School occupies a position of considerable leadership throughout the country.

Taking into account the facts given above, and the philosophy stated previously, certain tentative conclusions concerning the character of the contribution that physical science can make, can be stated. Thus, it seems that, at present, this contribution must be made in special science courses. That this need always to be true, or that the contribution can only be made under such conditions, by no means follows from the application of the philosophy. Although the course materials as developed

are cast in the mold of an integrated two-year sequence in the physical sciences, it is hoped that they will prove sufficiently general to be helpful in suggesting what the physical sciences have to offer for general education.

The steps followed in selecting units are set forth in Figure 2. This diagram follows from Figure 1. The relationships between the *complex* The individual in his Basic Aspects of Living and the two classes of Needs and the Values are redepicted at the top of Figure 2. This diagram further indicates that the Science Content of a unit is derived most directly from those Needs that are met through subject-matter. It may often happen that the other type of needs, or the values, may suggest subject-matter also. Thus, while the need of the adolescent for self-assurance is one that is probably not usually met directly through subject-matter, it may well be that information concerning normal variability with respect to height, weight, sexual maturation may help to meet this need. The characteristics of personality listed under the three Educational Values, similarly do not ordinarily suggest subject-matter. That is we do not usually have subject-matter dealing with creativeness, cooperativeness, social sensitivity, and the rest. However in the working out of one of the units (No. 9 in the list of units given at the end of this article) some of the

FIGURE 2
THE DERIVATION OF A UNIT IN SCIENCE


The INDIVIDUAL in his BASIC ASPECTS OF LIVING.
NEEDS met through knowledge of student problems.
NEEDS met through subject matter.
MAJOR EDUCATIONAL VALUES
SCIENCE CONTENT
METHOD.
Broadly conceived to include activities designed to meet needs, develop characteristics of personality, and to secure understandings.

subject-matter of the unit dealt specifically with reflective thinking and with the attitudes that certain scientists have exhibited in some of their historic experiments. The relatively smaller contributions of Needs, and of Values, to Content are indicated by the use of a dotted line to connect them to *Science Content* in Fig. 2.

The statements of understandings and inquiries which constitute the Science Content of a unit, will suggest activities (see the box marked Method in Figure 2) designed to develop understandings. The term "understanding" should be clearly distinguished from mere "information." As the science committee states

> The term "understanding" is here used to denote a major conception so grasped as to illuminate its connections with related conceptions and to result in significant changes in the individual's behavior.
>
> A principle, for example, becomes an understanding for an individual only when and as it throws new light for him on a group of relationships not previously sensed and so brings about a reorganization of his behavior.[18]

It is obvious that *understandings* of this character may be developed from subject-matter suggested by *inquiries* as well as from that suggested by declarative sentences. These activities are of many sorts—demonstrations, student experiments and projects, library research, discussions, excursions, witnessing of motion pictures, and others, selected because of their probable contribution to student understandings. However, it will be noted in Figure 2, that solid lines are also drawn from the group of Needs at the left, and from the Major Educational Values, to the box marked Method. These lines have been so placed to show that activities are carried on for other purposes than to develop understandings. The Science Content of a unit, selected mainly because of its contribution to Needs that may be met through Subject-Matter, is conceived as a sort of flexible boundary within which a wide variety of activities may go forward. Thus, the interest that many children have in experimentation is not directed toward any one particular thing, in many cases. Hence no harm is done to their personal interests by guiding their activities so as to produce understandings within the unit. On the other hand, certain children may have an intense desire to follow up a certain interest. It may be possible to direct this interest so as to make it motivate activities selected because of their contribution to understandings in the unit. Teachers owe to students the opportunity to widen the range of their interests and, in some cases students should no doubt be led to shelve, temporarily, some line of work in which they have great interest, while they investigate another field of endeavor. However, it may be that, at the particular moment what the student most needs is to be allowed to work uninterruptedly on his interest, or perhaps, through that work, to achieve a degree of recognition in his group that has previously been denied him. Even though such activity leads the student somewhat astray from the main theme of the unit, it should be permitted.

Many of the activities of a unit are selected because they help to develop characteristics of personality associated with the Major Educational Values. This is perhaps best illustrated by some of the specific abilities involved in reflective thinking. Teachers always test the results of their instruction in some fashion. This testing may be planned so as to achieve two results. While evaluating the student's understanding of a certain principle, or a small group of principles, his Ability to Apply Principles (one of the specifics referred to above) may be tested at the same time. Instead of performing routinized laboratory experiments, the student may devise experiments to solve problems, thereby testing his Ability to Plan Experiments to Test Hypotheses (another of the specifics).

These, then, are the relationships be-

[18] Thayer, V. T., and Others. *Op. cit.*, p. 55.

tween the various factors involved in setting up a unit as they are depicted in Figure 2. But let us examine more closely just what is meant by some of the terms used.

In order to utilize *Needs* effectively in setting up the units, the writer found it desirable to make his own statement of needs. These fell into two classes, as was suggested previously. Both lists are heavily derivative from the science committee's report,[19] although some shifting and restatement seemed necessary. Further discussion of these Needs and of the Educational Values will be postponed until they have been tabulated in three separate lists.

Needs Around Which Units in an Integrated Physical Science Course May Be Developed. (Needs Met Through Subject Matter)

1. The need for a rational world-picture or model.
2. The need for a workable philosophy of life, *i.e.*, ideals of conduct which will actually function in the life of the individual.
3. Needs derived primarily from the individual's membership in society and the economic order:
   a. the need to know of man's use of energy and the economic and social effects thereof.
   b. the needs arising from the adolescent's position as a producer and consumer of goods.
   c. the need for vocational guidance.
   d. the need to know of man's use of materials and the natural resources and the economic and social effects thereof.
4. The need of the individual to understand his own physiological functions and his body's development to the end that mental and physical health may result.

Needs Met Through an Intimate Knowledge of the Student and His Problems and Through Work with the Individual or a Flexible Class Procedure, or Through Both

1. The need for vocational guidance. Emphasis is here to include in each unit activities which will explore the vocational possibilities of the unit materials.
2. The needs arising from the adolescent's position as a producer and consumer of goods. In each unit, wherever possible, the applications of the science content to the problems of the consumer shall be stressed.
3. The needs of the individual to understand his own physiological functions and his body's development to the end that mental and physical health may result. Consideration of this need, separate and apart from its unit selection function (see preceding list) suggest that each unit should, so far as is possible, relate the physical phenomena to the human body (effects of noise on the nervous system, etc.) and that the implications of the material for understanding of bodily function and for health should not be neglected.
4. The need for self-assurance. This need is met, in part at least, through making certain that each person has a chance to achieve to his own satisfaction. One aspect of this need is the emotional assurance of economic achievement. Chances to work as a laboratory assistant, to do testing of commercial products, to make things, may help in this direction.
5. The need for self-expression. In many ways tied up with 4 above. Meeting the need for self-assurance would also require an emphasis on creativeness as listed under the educational values.
6. The need for personal interests. Met, in part, through encouraging the pupil to engage in a wide range of activities, to indulge in hobbies, etc.

The Major Educational Values. (Together with the characteristics of personality, marked, a, b, c, which contribute to the values.)

1. Furthering the uniqueness and worth of the individual.
   a. Creativeness
   b. Personal Interests
   c. Appreciations
2. Effective social participation.
   a. Social Sensitivity
   b. Cooperativeness
3. The use of intelligence.
   a. Reflective Thinking
      (1) Ability to discuss and define problems
      (2) Ability to observe phenomena accurately
      (3) Ability to select data pertinent to a problem
      (4) Ability to collect, analyze, and draw inferences from data:
         (a) Familiarity with reliable sources of information
         (b) Collection of data
         (c) Organization of data
         (d) Analyzing information and drawing inferences (Interpretation of Data)
      (5) Ability to plan experiments to test hypotheses
      (6) Ability to apply principles to new situations
      (7) Scientific attitudes
   b. Readiness to act on the basis of tentative judgments
   c. Self-direction

It is probably not necessary to discuss each item in each of the three lists in turn,

[19] Thayer, V. T., and Others: *Op. cit.*

and space does not permit. Comment on some portions of the lists does seem desirable in order that misconceptions may be avoided.

The term world-model, as used in the first list, is held to mean one's picture, or conception, of the universe as a whole. In teaching, the emphasis would usually be upon the immediate and the proximate rather than upon the remote in time and space. However, we would not rule out the cosmic completely, but would rather agree with Bertrand Russell that "the man who holds concentrated and sparkling within his own mind, as within a camera obscura, the depths of space, the evolution of the sun and the planets, the geological ages of the earth, and the brief history of humanity, appears to me to be doing what adds most to the diversified spectacle of nature. I would not abate this view even if it should prove, as much of modern physics seems to suggest, that the depths of space and the 'dark backward and abysm of time' were only coefficients in the mathematician's equations. For in that case man becomes even more remarkable as the inventor of the starry heavens and the ages of cosmic antiquity: what he loses in knowledge he gains in imagination.[20]

The need for a *world-model* and the need for a workable *philosophy of life* are often considered to be virtually the same. In the science committee's report,[21] they are treated as one. The connection is admittedly close, for "Philosophy has no other subject-matter than the nature of the real world, as that world lies around us in everyday life, and lies open to observers on every side." [22] Furthermore there is no question in the mind of the writer but what those major scientific ideas, such as evolution, determinism, energy, efficiency, and operational thinking, which are so basic to the development of a satisfying world-model, are no less valuable to the adolescent in formulating his philosophy of life. However if we take for our definition of this last "a conception of values that will guide action" and believe, as does a recent writer that an important goal for philosophy is "to have life constantly achieve a perspective which relaxes it from the nervousness of current circumstance," [23] a separate consideration seems justified.

The group of four needs of the adolescent listed under item three in the first list of needs, illustrate the point made earlier with the respect to the theoretical possibility of determining all the desirable outcomes of instruction by a study of the individual alone (page 6). The needs as given here are the needs of the adolescent. But they deal with areas in which the most severe dislocations are occurring in the economic and social life of today. Hence in providing the understandings which will meet the adolescent's needs in these areas, we may also meet the demands of society that education provide a background of ideas and experience to function in the treatment of such problems as conservation, floods, and drought.

It will be noticed that needs 1, 2, and 3 from the second list are the same as 3c, 3b, and 4 from the first list. This duplication was made deliberately with the idea that, while these needs might function only occasionally in their capacity of determiners of units in a physical-science course, they nevertheless represented emphases that might be made in most units. Hence, in figure 2, they would appear in both the left-hand, and the central boxes of needs. The other needs in the second list (4, 5, and 6) are those which, in the writer's opinion, are to be met best through the treatment of the individual student.

[20] Russell, Bertrand. *Education and the Modern World.* Norton, New York, 1932, p. 11.

[21] Thayer, V. T., and Others. *Loc. cit.*

[22] Pringle-Pattison, A. S. "Philosophy and Philosophical Studies." *Encyclopedia Britannica,* 14th edition, volume 17.

[23] Raup, Bruce. "Philosophy and Education." *Teachers College Record* 38: 218–22, 1936 (Dec.).

The Selection of Units. The units, whose titles appear at the end of this article, were set up to meet needs given in the first of the above three lists. It seems obvious that units that attempted to deal with each of the needs in that list in turn would not be teachable. The world-model, for example, cannot be developed in one unit but should permeate all, or nearly all of them. The same point may be made with respect to the philosophy of life, and most, or all of the others in the list. The one unit that comes nearest to being set up to meet a single need is No. 11. Consequently, the units as formulated represents the writer's interpretation of how the needs should be applied in terms of what he knows to have succeeded in his own teaching and of the complete Lincoln School situation—physical set-up, number and character of students, etc. It is quite apparent that another person, using the same technique and working in a different situation, would almost surely come out with a different list of units. It is even possible that this procedure might be employed in an incomplete and insincere manner to rationalize the teaching of courses virtually unchanged from stereotyped physics and chemistry courses. The deviation of the list of units from traditional subject-matter in those fields is perhaps the best earnest that such was not the case here. However there is no disposition on the part of the writer to think of the units as fixed or final. Units may be changed, dropped, and new ones added as circumstances demand. The one thing that is considered reasonably stable is the plan itself.

In the larger report of which this article is a condensation, all of the units are written up, one in great detail, and all in sufficient length to show how the unit was chosen in terms of the first list of needs, to indicate the science content of the unit, and to show how certain of the other needs might be met, and certain of the characteristics of personality listed under one or more of the Educational Values might be developed. With both Needs and Values it is apparent that any single unit can go but a short distance in the direction of their achievement.

Space forbids any description of individual units. However four points-of-view, or emphases, that were made in connection with the units may be given here. These are:

1. John Dewey has said, "Unless our schools take science in its relation to the understanding of those forces which are now shaping society and, still more, how the resources of the organized intelligence that is science might be used in organized social action, the outlook for democracy is insecure.[24] This quotation re-emphasizes the point that, as part of their contribution toward furthering the cause of a democratic society, science teachers should stress the social implications of their material. This is probably equivalent to saying that the problems of modern life to the solution of which the physical sciences may make contributions should be the points of departure for much of the work of the course.

2. The first emphasis deals with the use to which scientific knowledge shall be put. The second is concerned with the method by which scientific knowledge is obtained. This emphasis states that not only shall science education be more certain than it has been in the past that its students can think reflectively, but that they should appreciate that in the scientific method they possess a "potential agency for ridding the present situation of its confusions and conflicts, and for making the transition to a society which will be emancipated from many of the undesirable traits of present life." [25]

3. While, in the writing of the units, there has been no hesitancy in cutting across subject-matter boundaries when the development of the unit seemed to require it, no particular merit should be attributed to the result of this, yet, rather novel procedure. Neither should a unit be condemned because it falls almost entirely within boundaries of traditional science subjects. In brief, integration of materials is not an end in itself, or a good in itself, but rather a means to an end.

[24] Dewey, John. "The Challenge of Democracy to Education." *Progressive Education* 14: 79–85, 1937 (Feb.).

[25] Dewey and Childs. "The Social-Economic Situation and Education." Chap. II, p. 61, in *The Educational Frontier*. D. Appleton-Century, New York, 1933.

4. An examination of the list of units, or of the more complete descriptions in the full report, may create an impression of a degree of fixity in the unit content that is not intended. In a recent working out of key questions for one of the units (No. 10) in this list, students contributed all but one of the key questions which were agreed upon for class study. Student committees took problems turned in by class members, accepted one suggestion from the teacher and proceeded to arrange the problems in what seemed a feasible teaching manner, later presenting them to the class as a whole for approval. Some changes were suggested at that time and decided upon by vote. The point is that, although by and large, the responsibility for the content of the course is the teacher's, he presumably having a breadth of training and experience not represented in the class, nevertheless the class members should have a very considerable share in planning the work of the group.

The list of units which follows represents one concession to college entrance requirements. Although the Lincoln School is one of the members in the so-called "Thirty-School Experiment" nevertheless there are several colleges in the east to which Lincoln's graduates go in considerable numbers who are not represented among the cooperating colleges. Hence, for certification purposes, and to assist students in their preparations for the C.E.E.B. examinations, it seemed desirable to group together in one year most of the material derived from the field of physics, and similarly in the other year, most of the material derived from chemistry. This seemed a particularly necessary procedure because students may elect to take just a single year of the two-year sequence. Accordingly the first eight units in the list are units, some or all of which shall be taught in one year, units 9–14 similarly fall in another year, and unit 15 is a summary unit to be given at the end of the two years.

Tentative List of Units for an Integrated Two-Year Sequence in the Physical Sciences

1. The region now occupied by New York City has come into existence as the result of a long sequence of geological events which today, as in the past, have operated to change the surface of the earth.
2. The climate of a given region is the result of the operation of a number of natural causes—wind, topography, etc. Climatic conditions are correlated with racial characteristics and economic and social conditions of the peoples of the earth. Soil erosion is the result of the combined effects of climatic conditions, geologic forces, and man's faulty use of the soil.
3. Moving bodies, be they members of the sun's family of planets or objects on the earth's surface, seem to move in accordance with the same laws. Knowledge of these laws furnishes an intellectual basis for social action in the control of the speed of automobiles.
4. The solar system is part of a universe which is vast in extent. Man has been able to discover organizations of stellar material into various systems.
5. Almost all available energy on the earth's surface is derived directly or indirectly from the sun in the form of radiation, important effects of which are called light and heat.
6. The increased application of energy to man's uses, resulting mainly from the discovery of ways to utilize the energy of fuels in doing the work of the world, has wrought profound effects upon present-day life.
7. Today's technological civilization has been made possible by the increased use of electricity, a form of energy capable of transmission over long distances.
8. Energy in the form of waves constitutes an important means by which information is received and imparted.
9. The development of techniques for reflective thinking and the perfection of more precise measuring instruments were essential steps in the growth of man's knowledge of chemical change. Chemical changes are important because of their common occurrence in daily experience and because of their use by industry. Ideologically the concept of chemical change furnishes a basis for systematizing many hitherto unrelated phenomena.
10. The processes by which our natural resources of fuels are made available for consumer use is fundamental to our present civilization.
11. The use of metals has played, and continues to play, a fundamental part in our present civilization.
12. Chemical and physical changes are the basis of all the activities of living organisms.
13. Modern scientific technology is equally capable of being used for the good or the ill of mankind.
14. Information and techniques of science may be employed to insure the consumer a higher quality of goods.
15. The development of scientific knowledge and techniques has reached such a point as to make possible a better society and a better living for everyone as judged by all the factors that constitute complete living.

Editorials and Educational News

MINUTES OF THE TWELFTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

HOTEL ALLERTON, CLEVELAND, OHIO
FEBRUARY 26, 27, 28, 1939

The dinner meeting was convened at 6:30 P.M. Sunday, February 26, 1939, with the following members present:

Fred Anibal	Elwood D. Heiss
Florence G. Billig	John A. Hollinger
G. P. Cahoon	Ralph E. Horton
Otis W. Caldwell	Philip G. Johnson
Harry A. Carpenter	Warren W. McSpadden
Gerald S. Craig	John C. Mayfield
Walter C. Croxton	Victor H. Noll
Harry A. Cunningham	Ellsworth S. Obourn
Francis D. Curtis	E. Laurence Palmer
Ira C. Davis	Ellis C. Persing
W. L. Eikenberry	Charles J. Pieper
Anna Gemmill	S. Ralph Powers
Earl R. Glenn	Carleton E. Preston
Benj. C. Gruenberg	Martin L. Robertson
Jennie Hall	C. L. Thiele
Robert J. Havighurst	Ralph K. Watkins

Following the dinner, S. Ralph Powers, president, presented a comprehensive paper entitled "The Meaning of General Education." This paper was followed by a stimulating and interesting discussion from the floor.

The President next called the regular business meeting to order.

The Secretary read a telegram from Hanor A. Webb expressing his disappointment on being unable to attend because of the death of his father. On motion of Mr. Palmer, duly seconded, the Association voted to instruct the Secretary to express its deep sympathy to Mr. Webb. The following telegram was sent: "Association expresses deepest sympathy in your bereavement."

The minutes covering the transactions of the Association for the current year were reported by the Secretary. On motion of Mr. Robertson, duly seconded, the report was received and approved as corrected by Mr. Noll. A full report of the minutes is attached.

The report of the Treasurer was presented and, on motion from the floor, duly seconded, was received and accepted.

The reports of Association Committees were next called in the following order:

1. Program Committee. The chairman, Mr. Anibal, presented the program and moved the dismissal of the committee. The motion was seconded and passed.

2. The Constitutional Revision Committee. In the absence of the chairman, Mr. Webb, the Secretary reported a letter received from him stating that no action of the committee seemed desirable at the present time. Adoption of the report was voted.

3. The Publications Committee. The chairman, Mr. Heiss, presented the attached report which was accepted.

4. A report from the chairman of the Committee on Elementary Science, previously dismissed, was called. Miss Billig reported that the portion of the report given at the last annual meeting would be completed and turned over to the Publication Committee.

5. The Committee on Secondary School Science. Mr. Anibal reported for the chairman, Mr. Hunter. He stated that the report had been printed in *Science Education* and that reprints would be distributed to the membership. The committee has been dismissed.

6. Committee on Teacher Training. The chairman, Mr. Watkins, reported

that some work beyond the report published in *Science Education* had been done and would continue informally. Reprints of the report will be distributed to the membership. The committee has been dismissed. It was voted to accept the report.

7. The Secretary reported the activities of the newly formed committee of the Department of Science of the N.E.A., as official representative of the Association.

8. The Committee on Policies. Mr. Noll, the chairman, presented the report attached. The report was fully discussed. A motion was made by Mr. Hollinger to amend the motion to adopt, to read as follows: "The proposed Coordinating Committee be appointed by the Executive Committee from written recommendations received from the membership." The amendment was seconded and adopted by vote. A motion by Mr. Havighurst to postpone further discussion of the motion to adopt until the Tuesday Business meeting was voted. A motion by Mr. Havighurst that the Secretary be instructed to have copies of the committee report prepared for distribution at the Monday meeting was voted.

9. The Nominating Committee. Mr. Gruenberg reported the deliberations of the Nominating Committee and presented the following slate:

For *President*—Fred Anibal
For *Vice-President*—Charles J. Pieper
For *Secretary-Treasurer*—Ellsworth S. Obourn
For the Executive Committee—S. Ralph Powers and E. Lawrence Palmer

The adoption was moved by Mr. Havighurst. Nominations were opened from the floor and Mr. Pieper proposed the name of Otis W. Caldwell for president and further that the other officers remain as of the current year.

Mr. Havighurst changed his motion to adopt the slate proposed by the Nominating Committee to read that a vote for president be taken at the Monday business meeting and that the Nominating Committee be instructed to prepare a new slate. The motion was seconded and carried.

Following the committee reports, the President opened the meeting to new business. It was recommended that the letter of withdrawal received from Mr. E. E. Wildman be referred to the Executive Committee for action. A proposal was made that some type of associate membership might be inaugurated by the Association.

Mr. Curtis moved that beginning in 1940 the Sunday meeting be designated as open for the consideration and transaction of Association business. The motion was seconded and carried.

Mr. Carpenter moved that the Association share half of the expenses of providing the program for the joint meeting of the N.A.R.S.T. and the National Council on Elementary Science held Saturday, February 25, 1939, at Hotel Statler, Cleveland, Ohio. The motion was seconded and adopted.

There being no further business the meeting was adjourned.

ELLSWORTH S. OBOURN,
Secretary.

REPORT OF THE SECRETARY
FEBRUARY 26, 1939

The minutes of the proceedings and transactions of the last annual meeting held at Atlantic City, N. J., together with the minutes of the meeting of the Executive Committee, have been placed in your hands and have been published in *Science Education*, the official journal, as prescribed in the by-laws of the Association. This is a report of the transactions carried on by your officers and Executive Committee during the current year.

Membership

During the current year the following persons have resigned from the Association: Miss Lillian Hethershaw and Mr. William G. Vinal.

The following persons have been officially elected to membership in the Association during the year: Mr. Louis M. Heil, Evaluation Staff of the Eight Year Study, Progressive Education

Association, University of Chicago, Chicago, Ill.; Miss Edith Selberg, State College of Education, Greeley, Col.; and Mr. A. N. Zechiel, Curriculum Staff of the Eight Year Study, Progressive Education Association, Ohio State University, Columbus, Ohio.

At the present time there are seventy-six paid members, including three life members and seventy-three annually-paying members.

Committees

All committees appointed and discontinued by the Executive Committee at its last meeting were properly notified as recorded in the minutes of the Atlantic City meeting. Reports from the Committee on Secondary School Science and Teacher Training of the Committee of Five have been edited and published in *Science Education*. The Executive Committee authorized funds for the purchase of reprints for distribution to the members of the Association.

During the year the committee, appointed two years ago to cooperate with the College Entrance Examination Board in re-defining its requirements, has completed its work under the direction of Mr. Horton. A report of this committee will be heard on the Monday program. Copies of the report will also be made available to the members.

The Nominating Committee appointed by the President was as follows:

Benj. Gruenberg (Chairman), G. P. Cahoon, and Herbert Arnold

The report of this committee will be made at the business meeting on Monday.

The motion of Mr. Noll voted at the last annual meeting, was carefully considered by the Executive Committee as noted in the proceedings of the Atlantic City meeting. The proposal was referred again to Mr. Noll for further instructions to the Executive Committee and also for a budget of proposed expenditures. When this was received from Mr. Noll, the President submitted two proposals to the Executive Committee for vote as follows: (1) that funds be voted from the Association to complete the work and publish the reports of the various sections

TREASURER'S REPORT FOR 1939

Received:		
Dues for 1938, 72 at $5.00	$360.00	
Dues adjusted to previous subscription to *Science Education*, 1 at $2.50	2.50	
Bank interest	15.88	
Cash on hand March 1, 1939	37.05	
Total	$415.43	
Deposit in Savings Account (less interest above)	785.17	
Total received		$1,200.60
Expenditures:		
E. E. Wildman—expenses Philadelphia meeting	$7.00	
Geo. W. Hunter—committee expenses	19.45	
To check exchange charge	1.18	
E. S. Obourn—secretarial expenses and mailing	31.67	
Model Printing Co.—for stationery	15.45	
Geo. W. Hunter—for mimeographing additional reports	9.50	
C. M. Pruitt—for 61 subscriptions *Science Education*	152.50	
E. S. Obourn—secretarial help	18.00	
C. M. Pruitt—13 subscriptions *Science Education*	32.50	
C. M. Pruitt—one back subscription *Science Educition*	2.50	
Ralph E. Horton—mimeographing committee report	13.84	
Homer LeSourd—treasurer dues to A.S.T.A.	5.00	
C. M. Pruitt—one subscription *Science Education*	2.50	
Madison Eagle—printing programs and cards	24.60	
E. S. Obourn—mailing and secretarial help	12.15	
Total expenditures		$347.84
Balance		$852.76
Deposit in Savings Account	$800.95	
Cash on hand in Checking Account	51.81	
Total		$852.76

Respectfully submitted,
ELLSWORTH S. OBOURN,
Treasurer.

of the Committee of Five; and (2) that money be voted by the Association for traveling expenses of a committee to be made up of the chairmen of the sub-committees of the old Committee of Five, this committee to consider the proposals made in Mr. Noll's motion and to report back to the Association. The Executive Committee voted unanimously "yes" on the first of the proposals and unanimously "no" on the second. As previously stated, the first of these proposals has been carried out and the reports will be distributed shortly.

It was the feeling of the Executive Committee that many very important issues had been raised by the proposal of Mr. Noll and that, in spite of the fact that it was unwilling to establish the precedent of voting Association funds for traveling expenses, these proposals should have further consideration for the welfare of the Association.

In line with this thought the President appointed a committee as follows: V. L. Noll, Chairman, Ralph K. Watkins, Robert J. Havighurst, Frank Jean, Frederich L. Fitzpatrick, and Harry A. Carpenter. A report of the purposes and preliminary plans of this committee will be made later at this meeting.

Recently the President has appointed the Secretary to represent the Association on a National Committee which has been organized by the Science Section of the National Education Association.

REPORT OF PUBLICATIONS COMMITTEE

The Publications Committee performed two tasks during the past year:

1. Each member of the Publications Committee read and edited the report of the Committee on Secondary School Science of the Association. This report is now available to everyone, having been published in the October, 1938, issue of *Science Education*.
2. Each member of the Publications Committee read and edited the report of the Committee on the "Training of Science Teachers." This report was published in the November, 1938, issue of *Science Education*.

The Publications Committee has not yet received a report from the Committee on Elementary Science.

It is our understanding that plans are under way for the preparation of a series of reports by our Association. The Publications Committee recommends that the Executive Committee of N.A.R.S.T. define the duties, if any, of the Publications Committee in this undertaking.

ELWOOD D. HEISS,
Chairman, Publications Committee.

REPORT OF THE NOMINATING COMMITTEE

At the Atlantic City meeting of this Association last year, Hanor A. Webb, in his presidential address, raised the question of unity and continuity in the Association's policies as depending on a consistent policy in the election of officers at the annual meetings. Mr. Webb recommended a formula for the succession in office as a means of insuring a development of Association policy. Although these recommendations were not adopted, the meeting voted to try the plan for one year.

The members of your Nominating Committee agree that this plan promises to be profitable for the Association. While the Committee is not authorized to make recommendations on general policy, it submits the following nominations for the year 1939–40, with the frank purpose of continuing the plan of succession proposed by Mr. Webb:

For *President:* Fred Anibal, Stanford University

For *Vice-President:* Charles J. Pieper, New York University

For *Secretary-Treasurer:* Ellsworth S. Obourn, New York University (John Burroughs School, St. Louis, 1939——)

For the Executive Committee: S. Ralph Powers, Teachers College, Columbia University, and E. Laurence Palmer, Cornell University

Respectfully submitted,

HERBERT J. ARNOLD,
G. P. CAHOON,
B. C. GRUENBERG, *Chairman.*

REPORT OF POLICIES COMMITTEE

I. The N.A.R.S.T. should take an active and leading role in stimulating research and publishing summaries of research on practical problems of science teaching such as:

1. Effective use of scientific aids to learning.
2. Methods and materials in developing scientific attitudes.
3. Methods of evaluating results of science teaching.
4. Analysis of scientific methods of problem solving of significance to laymen.
5. Synthesis and evaluation of science materials from curriculum workshops.
6. Function of the laboratory in the learning of science.

II. The Association should adopt a change from formal programs of annual meetings except the dinner meetings:

1. The whole membership should be organized into working committees.
2. The time and place of annual meetings shall be used for meetings of the working committees.
3. The tentative reports of working committees shall be presented for consideration before the entire Association at a final general meeting, probably on Tuesday afternoon.

III. The reports of working committees shall be published in the official magazine of the Association or in special bulletins as they become available.

IV. A central coordinating committee shall suggest projects, recommend personnel of working committees and coordinate their work.

V. Working committees once set in motion shall continue until a final report is made, or until such committees declare themselves inactive.

VI. Membership of working committees may be adjusted by the coordinating committee according to interests of individuals or by addition of new members.

VII. Each committee including the coordinating committee shall elect its own chairman.

VIII. The coordinating committee is responsible directly to the Association as a whole.

IX. The coordinating committee shall consist of three members appointed by the executive committee taking into account written nominations submitted by members of the Association.

X. The members of the coordinating committee shall serve for terms of three years, excepting that the first group of three members shall serve for one, two and three years respectively as determined by lot. Thereafter one new member shall be appointed annually subject to the approval of the Association.

XI. The Association shall cooperate in all practical ways in programs of other organizations of science teachers.

HARRY CARPENTER,
R. J. HAVIGHURST,
F. L. FITZPATRICK,
R. K. WATKINS,
F. C. JEAN,
VICTOR NOLL, *Chairman.*

MINUTES OF THE BUSINESS MEETING
FEBRUARY 27, 1939

The meeting was called to order by the President, S. R. Powers, at 11:00 A.M., following the presentation of papers as recorded in the published program.

The mimeographed report of the Committee on Policies was distributed at this meeting.

A motion was made to refer to the Executive Committee the suggestion of Mr. Curtis (made earlier in the morning session) that the Association define specifically what is meant by research in the teaching of science. The motion was seconded and voted.

The next order of business called was the election of officers. Mr. Robertson moved to substitute the following slate for consideration:

For President—Otis W. Caldwell
For Vice-President—Fred Anibal
For Secretary-Treasurer—Ellsworth S. Obourn
For the Executive Committee—S. R. Powers and C. J. Pieper

The motion was seconded and put to the members by Mr. Curtis. The motion was carried. Mr. Anibal was nominated for President by Mr. Gruenberg. Election was by ballot, Mr. Eikenberry and Mr. Craig acting as tellers. The vote was in favor of Mr. Caldwell. Mr. Caldwell was declared elected on motion for the casting of a unanimous ballot made by Mr. Craig, duly seconded. Upon motion from the floor, duly seconded, the Secretary was instructed to cast a unanimous ballot for Mr. Anibal for Vice-President, and Mr. Obourn for Secretary-Treasurer. The motion was carried.

Mr. Gruenberg nominated Mr. Palmer for the Executive Committee from the floor. Voting was conducted by ballot on the following names for the Executive Committee: S. R. Powers, C. J. Pieper, E. L. Palmer. Mr. Craig and Mr. Eikenberry served as tellers and reported Powers 19, Pieper 12, and Palmer 8. Mr. Powers and Mr. Pieper were declared elected to the Executive Committee.

Upon motion by Mr. Craig, duly seconded, the vote was declared unanimous.

The meeting was adjournel upon motion from the floor, duly seconded.

ELLSWORTH S. OBOURN,
Secretary.

MINUTES OF THE BUSINESS MEETING
FEBRUARY 28, 1939

The meeting was called to order at 11:15 A.M. by the President, S. R. Powers, following the panel discussion on teacher training as published in the program.

The first item of old business was the consideration of the report of the Committee on Policies presented at the Sunday meeting by the chairman, Mr. Noll. The

motion to adopt the report, made previously by Mr. Havighurst, was opened for discussion. By general agreement, it was decided to consider the report, item by item.

Item I. The N.A.R.S.T. should take an active and leading role in stimulating research and publishing summaries of research on practical problems of science teaching. (See attached report for subdivisions.) This item was adopted upon motion by Mr. Robertson, duly seconded.

Item. II. The Association should adopt a change from formal programs of annual meetings except during the dinner meeting. (See attached report for sub-divisions.)

Discussion:

Mr. Eikenberry—Is not sure that the proposal will work because of the confusion. Willing to try it out.

Mr. Powers—There will be a Program Committee which might canvass the field for papers and research.

Mr. Noll—The Program Committee would arrange formal parts of program. The Coordinating Committee would arrange the program proposed in Item II.

Mr. Cahoon—Proposed a transition type of program leading from the present into the newer plan.

Mr. Noll—Arrangements might be made in a hotel for committee rooms. This would provide the physical set-up for the program. The newer program is not mandatory, therefore, no transition period needed. It might be tried for a year or two.

Mr. Heiss—Proposed program too rigid. There should be a plan for open meetings and for presentation of outside research papers. In favor of adopting Mr. Cahoon's proposal of a transition period.

Mr. Anibal—It is desirable to continue the cooperation with other outside groups through joint meetings.

Mr. Curtis—Puzzled by the new proposal. There appears to be a degree of regimentation. It may not be practicable to organize the entire membership into committees because of the diversity of interest. Who will assign members to the committees?

Mr. Powers—Project plan as if in operation during the current meetings.

Mr. Noll—The Coordinating Committee would make assignments to committees after considering the wishes of each member. In agreement with Mr. Anibal that cooperation with other organizations should be continued.

Mr. Robertson—Offers an objection to meeting devoted to committee reports because of the impossibility of getting many reports in.

Mr. Havighurst—There would probably not be more than five committees. Fifteen or twenty minutes might be given for each report. If a report was in final form, more time might be devoted to it.

Mr. Powers—It would be the function of the Coordinating Committee to assign and plan for time.

Mr. Croxton—How much research could be done by these committees in two days? Or is the purpose to stimulate, review, evaluate and coordinate research?

Mr. Noll—The object is to provide time, not now available, for committees to work. Research done or studied might be presented.

Mr. Powers—Would it help in Item II to insert after the word, "program," the idea that this has reference primarily to the fore-noon programs of Monday and Tuesday of the present procedure?

Mr. Havighurst—In answer to Mr. Croxton's question. Committees would not necessarily conduct research. They might or perhaps they would be evaluating and assembling research. They might be preparing tests and devices during the year. Such a committee might eventually reach the point where a report was desirable. It might then use committee time in planning the report or in writing it.

Mr. Croxton—What if a person was

conducting research not specifically within one of the committee areas?

Mr. Havighurst—The report could be given at one of the open meetings.

Mr. Thiele—Would non-members working on problems be included in the program plan?

Mr. Noll—It would certainly take in the work of non-members.

Mr. Thiele—The membership might be built up by bringing in non-members. We should permit other people to come in on such a plan.

Mr. Noll—The researches, progress and deliberations of the committees would be presented in open meetings.

Mr. Powers—Suggests two half-day periods for such a plan as called for in Item II.

Mr. Noll—At least three half-day periods should be set aside, one to be used for reporting.

Mr. Obourn—Called attention to the possibility of using Sunday afternoon as a time for committee meetings.

Mr. Preston—For those not interested in research we should provide one meeting for hearing outside papers. One meeting should also be provided for cooperation with other groups of the A.A.S.A.

Mr. Powers—The committee meetings should be open meetings.

Mr. Watkins—It all seems a question of time. We must provide time for committee meetings and deliberations.

Mr. Craig—Suggests that the Coordinating Committee be left to the Executive Committee during the next year and give time for the Executive Committee to take necessary steps. We still need a program committee.

Mr. Havighurst—The Program Committee have at least one meeting for reporting research. Moved the adoption of Item II with the understanding that the Program Committee arrange as much time as possible for the working committees but that there should be at least one meeting open to contributed papers. The motion was seconded. Discussion:

Mr. Watkins—This is only tentative and may be rescinded at any future time.

Mr. Eikenberry—Proposes that contributed papers and committee reports might be included in some meeting.

Mr. Havighurst agreed to change his motion to include Mr. Eikenberry's suggestion. The question was called and the item voted.

Item III. The reports of working committees shall be published in the official magazine of the Association or in special bulletins as they become available. The item was adopted upon motion, duly seconded.

Item IV. A central coordinating committee shall suggest projects, recommend personnel of working committees and coordinate their work. The adoption of the motion was moved and seconded.

Mr. Robertson—Moves that the words, "with the cooperation of the Executive Committee," be inserted after "coordinating committee." The amendment was seconded and adopted. The question on the motion to adopt Item IV was called and adopted by vote.

Item V. Working committees once set in motion shall continue until a final report is made, or until such committees declare themselves inactive. The item was adopted on motion, duly seconded.

Item VI. Membership of working committees may be adjusted by the Coordinating Committee according to interests of individuals or by addition of new members. The item was adopted on motion, duly seconded.

Item VII. Each committee including the Coordinating Committee shall elect its own chairman. The item was adopted on motion, duly seconded.

Item VIII. The Coordinating Commit-

tee is responsible directly to the Association as a whole.

Mr. Eikenberry moved that this item be eliminated. The motion was seconded.

Mr. Noll—The idea of this item was to make the Coordinating Committee responsible for the work plans and organization of the Association and independent of the Executive Committee which would conduct the business.

Mr. Eikenberry—The cooperation of these committees is very essential.

The question on Item VIII was called. The motion to eliminate Item VIII was carried.

Item IX. The Coordinating Committee shall consist of three members appointed by the Executive Committee taking into account written nominations submitted by members of the Association. The item was voted on motion from the floor, duly seconded.

Item X. The members of the Coordinating Committee shall serve for terms of three years, excepting that the first group of three members shall serve for one, two, and three years, respectively, as determined by lot. Thereafter one new member shall be appointed annually. The item was adopted on motion, duly seconded.

Item XI. The Association shall cooperate in all practical ways in programs of other organizations. The item was adopted on motion, duly seconded.

Mr. Cunningham—Moved the adoption of the complete report as amended. The motion was seconded and carried.

Mr. Havighurst—Proposed that nominations for the Coordinating Committee be handed in writing to the Secretary during the day.

There being no further business the meeting was adjourned.

MINUTES OF THE ANNUAL MEETING OF THE EXECUTIVE COMMITTEE

Hotel Pennsylvania, New York City

April 1, 1939

The annual meeting of the Executive Committee was held at Hotel Pennsylvania, New York City, because of circumstances which prevented assembling in Cleveland at the time of the regular meeting. The following members were present: Otis W. Caldwell, Charles J. Pieper, S. Ralph Powers, E. S. Obourn.

The business of the Association was transacted in the following order:

I. *New Members*

The following names were presented and after individual consideration were voted favorably: N. E. Bingham, Karl F. Oerlein, H. Emmett Brown, Eugene A. Waters, John S. Richardson, Shailer A. Peterson, W. R. Teeters, J. Darrell Barnard, Charles Gramet, Clark W. Horton, Edna W. Bailey.

The Secretary was instructed to conduct a poll of the membership on each name.

The establishment of an emeritus membership in the Association was considered. It was proposed that this be available for former active members who have retired from service in the field. It was also suggested if such a type of membership should be established that it should be exempt from dues and would not carry the usual subscription to *Science Education*. The Secretary was instructed to prepare a proposal including the above suggestions to be submitted at the next meeting of the Association.

II. *Committees*

1. A Committee on Elementary Science was appointed after a plan proposed by Miss Florence Billig for a smaller working committee was discussed. Miss Billig was appointed chairman and the Secretary was requested to secure suggestions from the chairman as to the membership of the committee.

2. It was recognized by the Executive Committee that the former committees on secondary school science and teacher training had been officially dismissed by the presentation of reports. The Secretary was

instructed to write to the chairman of these committees to see if there were further problems raised by the previous studies which would warrant the re-appointment of the committees.

3. A committee on adult education was appointed with Benjamin Gruenberg as chairman. The Secretary was instructed to secure proposals for membership of this committee from the chairman and also to request a plan of procedure.

4. S. R. Powers, as retiring president, was made the chairman of the Constitutional Revision Committee and official Parliamentarian.

5. The Secretary was continued as the Association representative on the National Education Association Department of Science Committee. The Secretary was instructed to attend the meeting of the committee on May 12, 1939, in Cleveland, Ohio.

6. Hanor A. Webb was continued as the Association representative to the American Science Teachers Association.

7. Charles J. Pieper was appointed chairman of the Program Committee and instructed to work with the new Coordinating Committee in formulating a program for next year. Mr. Anibal and the elected Chairman of the Coordinating Committee were also appointed as members of the Program Committee.

8. The Committee to Cooperate with the College Entrance Examination Board, with Ralph E. Horton as chairman, was continual for one year. The Secretary was instructed to request Mr. Horton to study the problems raised by his report and propose a plan for further work of the committee if it seemed wise. The Secretary was instructed to write the Publications Committee regarding the publication of the report of this committee.

9. Fred Anibal was designated as the member to summarize the research in the field for the ensuing year.

10. The Publications Committee was reappointed with E. D. Heiss as chairman. The President was instructed to formulate a letter to be sent to the respective Publications Committees of the N.E.A. Department of Science, the American Science Teachers Association and the National Association for Research in Science Teaching requesting that these three committees begin at once a cooperative study leading to a common solution of the problems of publication confronting each organization.

III. *Association Policies*

1. The report of the Policies Committee made by Mr. Noll at the Cleveland meeting was considered, and approved as amended. The Coordinating Committee was appointed from nominations submitted by members at the Cleveland meeting, the respective tenure being determined by lot as provided in the adopted report:

Victor Noll—1 year
Francis D. Curtis—2 years
Gerald Craig—3 years

2. It was moved and voted that the plans for the next annual meeting be formulated and carried out by joint action of the Program and Coordinating Committees.

3. The matter of publishing a revised directory was considered. It was decided to table the matter until 1940 with the suggestion that a mimeographed list of members, committees, officers, *etc.*, be sent to the membership.

4. A suggestion to the Executive Committee made by F. D. Curtis, regarding the limiting of the number of sessions of the Association at the time of the Annual Meeting as well as limiting the number of papers at any single session, was referred to the Program Committee.

5. A suggestion to the Executive Committee made by W. L. Eikenberry proposing that the N.A.R.S.T. plan and carry out one of its annual sessions considering the teachers of the local area, was referred to the Program Committee with power to act.

ELLSWORTH S. OBOURN,
Secretary.

Abstracts

GENERAL EDUCATION

SYMPOSIUM: "Statutory Status of Six Professions." *Research Bulletin of the National Education Association* 16: 184–234; September, 1938.

The following six professions are considered: accountants, architects, lawyers, nurses, physicians, and teachers. The following points are discussed for each profession: legal regulations for admission to the profession, legal provisions for expulsion from profession and for revocation of licenses, and sampling of cases brought to trial against offenders.

—C.M.P.

LEE, EDWIN A. (Chairman). "Teaching A Man's Job." *The Phi Delta Kappan* 20: 215–240; March, 1938.

This is a Phi Delta Kappa committee report. It constitutes one of the most significant reports that have been published. It is now available in book form. This is an article all teachers should read.

—C.M.P.

PITTENGER, B. F. "The General College in Teacher Education." *The Educational Forum* 3: 5–12; November, 1938.

Teacher education in this country is mostly in the hands of about 250 teachers' colleges and normal schools and 600 other colleges and universities. Competition between the teacher colleges and the general college is keen. In this struggle for dominance the general college would seem to have a decided advantage if it will only live up to its possibilities. Dean Pittenger appraises the relative merits of teachers' colleges and general colleges as centers for the education of teachers. The critical appraisal seems fair to both types of institutions.

—C.M.P.

NEWHOUSE, JAMES. "I was a Professor in a Christian College." *The Social Frontier* 4: 285–289; June, 1938.

This article presents episodes from an academic career in a Christian College. The episodes here set forth could have occurred in other than a church school. You will enjoy the author's comments on his experiences on a $1400 salary in a small midwestern college. Many will say "it couldn't have happened in an American College" but many others can attest to having experiences similar to those of the author.

—C.M.P.

ANONYMOUS. "Archaeology for the Future now being Sealed in Crypts." *Science News Letter* 34: 179–180; September 18, 1938.

Representative samples of the Twentieth Century are expected to be dug up thousands of years hence by Archaeologists of that time. A "Time Capsule" containing samples of today are being prepared for burial at the site of the 1939 New York World's Fair. In Atlanta, Georgia, Oglethorpe University is working hard to pack a Crypt of Civilization to be excavated in 8113 (a date as far in the advance of the present as ours is in advance of the earliest recorded date in Civilization—4241 B.C.).

—C.M.P.

SYMPOSIUM. "Crime." *Building America* 4: 1–32; November, 1938.

This study unit discusses these questions: (1) What has been the history of crime in America? (2) What are the causes of crime? (3) What things are being done by the police, the courts, and prisons in dealing with criminals?, and (4) What are the American people doing to prevent crime?

—C.M.P.

FINCH, HARDY R. "Film Production in the Schools." *Educational Screen* 17: 216–218; September, 1938.

Today over 200 schools throughout the United States are producing amateur films. This article is a brief survey of this growing activity. Many specific illustrations are given of places where films of different sorts are being made in connection with school work. No examples are given in the science field, except indirectly through health and safety. Are there not science teachers who have movie making as a hobby, producing films which will aid in this area of instruction?

—O. E. Underhill.

DOANE, DONALD C. "What I Want from the Distributor of Educational Films." *Educational Screen* 17: 289–290; November, 1938.

This follows a similar article by the same author previously reviewed, discussing what the teacher desires of the producer of educational films. Teachers desire a more adequate film catalog. The short descriptions given do not allow for intelligent selection, nor for preparing the class before the film is shown. The

practice of sending some other film than the one ordered is deplored. The teacher prepares the class for certain work and then on the day of the class some other film arrives. Teachers' guides should be prepared for every film. If a film is worth preparing, it is also worth a teachers' guide. Catalog descriptions do not enable the user to distinguish between films ten to fifteen years old and the newer ones. Teachers are becoming discouraged because an attractive catalog description brings a film so full of out-of-date costumes, and poor acting that it becomes a comedy to the class instead of a source of information. It is recommended that distributors build their library of educational films on school needs rather than on the chance procedures which apparently now control such selection.

—O. E. Underhill.

ANDREWS, BENJAMIN R. "Consumer Education." *Social Education* 2:414–419; September, 1938.

The author discusses four recent books in the field of consumer education.

—C.M.P.

BEARD, CHARLES A. "A Memorandum from an Old Worker in the Vineyard." *Social Education* 2: 383–385; September, 1938.

The author makes a plea for "a considerate adjustment, for a balanced adjustment" between history and current problems in social study courses.

—C.M.P.

BAKER, G. DERWOOD. "An Eleventh-Grade Field Study: The Coal Industry." *Educational Research Bulletin* 17: 173–188; October 19, 1938.

This article describes a Lincoln School experiment in experiencing the realities of the social order. Fifteen members of the eleventh grade went to the coal regions of Pennsylvania and West Virginia in search of first-hand information about the coal and steel industries. A fairly complete outline summary of the study is included.

—C.M.P.

RATHS, LOUIS. "Some Evaluations of the Trip." *Educational Research Bulletin* 17: 189–208; October 19, 1938.

The Lincoln School coal and steel industry trip (abstracted above), is evaluated in this article.

—C.M.P.

SYMPOSIUM. "The Eight-Year Study of the Progressive Education Association." *Educational Research Bulletin* 17: 209–254; November 16, 1938.

This bulletin gives the reports of the Director and the Curriculum Staff for 1938. The reports: (1) The commission on the relation of school and college by W. M. Aikin; (2) Development of core curriculums by Harold B. Alberty, (3) Social studies by S. P. McCutchen, (4) Travels of a curriculum associate among the secondary schools by H. H. Giles, and (5) Experimental work and progress in the field of science by A. N. Zechiel.

—C.M.P.

ANDERSON, HOWARD R. "Increased Efficiency in Grading Examinations." *Social Education* 3: 30–32; January 1939.

The article suggests means by which the time necessary to grade examinations may be reduced materially. Stencil keys and answer sheets save both time and money.

—C.M.P.

DEMIASHKEVICH, MICHAEL. "More on the Reform of Secondary Education in Germany." *The Educational Forum* 3: 81–95; November, 1938.

This is an excellent summary of the present educational set up in German secondary schools as decreed by an ordinance of January 29, 1938. The ordinance is given in complete detail. It includes the curriculum and the German basic philosophy of secondary education.

—C.M.P.

CHRISTOFFERSON, H. C. "Geometry—A Way of Thinking." *The Educational Forum* 3: 39–48; November, 1938.

A student of geometry needs to learn many facts and principles about form and space; and how statements are proved and the nature of sound proof. Practically all of this article deals with theorems in non-geometric thinking—generalization processes in everyday life and their opposite or converse. The author presents many examples where sound proof is needed. Here is an example from advertising in which all facts are not available or evident.

A. The Generalization based on inductive thinking: All beautiful girls smoke x cigarettes, or if you are beautiful you will smoke x cigarettes.

B. The opposite: If you are not beautiful you will not smoke x cigarettes.

C. The converse: If you smoke x cigarettes you are or will be beautiful.

D. The opposite of the converse: If you do not smoke x cigarettes you are not and cannot be beautiful.

—C.M.P.

RUSSELL, WILLIAM F. "For the Defense of Democracy." *Teachers College Record* 40: 181–205; December, 1938.

This is a section of the Report of the Dean of Teachers College for the year 1937–38. The author contrasts and compares the philosophies of democracies and dictatorships, pointing out the implications for education. The problem in our democracy is education for political democracy and education for economic democracy.

—C.M.P.

WEST, ROSCOE L. AND MARTIN, LYCIA O. "Relationship Between Scholarship and Success in Student Teaching." *The Educational Forum* 3. 3–6 (Part II); November, 1938.

A study of the student teaching marks of 96 Phi Delta Kappa members of the New Jersey State Teachers College at Trenton, New Jersey, form the basis of this study. A distinct relationship between scholarship and student-teaching ability was found. Phi Delta Kappa members were selected wholly on a basis of scholarship.

—C.M.P.

EVENDEN, EDWARD S. "Research in the Field of Normal School and Teachers College Education at Teachers College. *The Advanced School Digest* 4: 2–12; October, November, 1938.

The author reviews research studies relating to teachers education that have been carried out at Teachers Colleges. The studies have been classified as follows: (1) Surveys in the field of normal school and teachers college education, (2) Historical studies in the field of normal school and teachers college education, (3) Studies in professional treatment of subject matter, (4) Administrative studies in the field of normal school and teachers college education, (5) Student personnel studies in normal schools and teachers colleges, and (6) Curriculum studies in normal schools and teachers colleges.

—C.M.P.

JEWITT, IDA A. AND HAYS, EDNA. "An Examination of Recent Literature on the Education of Teachers." *Teachers College Record* 40: 129–149; November, 1938.

The first part of the article discusses teacher education in the United States since 1917. There is a bibliography of 104 titles deemed representative of literature on teacher education since 1917.

—C.M.P.

HOPKINS, L. THOMAS. "Emerging Emphases as to Learning." *Teachers College Record* 40: 119–128; November, 1938.

The emerging emphases are stated as follows: (1) When a child learns, he learns all over, (2) All good learning is seeking satisfaction for personal goals, (3) All learning is relating and (4) All desirable learning is creative. A summarizing principle would be as follows: Every child is capable of learning anything which he sees a personal need for learning.

—C.M.P.

KING, A. K. "Enigma of the South. *Social Education* 3: 4–12; January, 1939.

The author, a professor at the University of North Carolina, paints a rather pessimistic picture of conditions in the South—its land waste, low per capita income, meager public and private educational and health services, and so on. The South in 1936 spent only one half as much per child in school as did the country as a whole. No southern state has as much true wealth per capita as the poorest state in other regions. In 1933–34 the average salary of teachers in Arkansas was $465; in New York state $2361. The total endowment of all Colleges and Universities in the South are less than the combined endowments of Harvard and Yale. The author believes if the present trend continues that there will be an absolute decline in population in the South and that a large proportion of the farmers will sink into a state of hopeless peasantry.

Soil and forest conservation, educational assistance, revocation of discriminative freight rates, and better markets for staple crops are essential needs if the South is to be saved.

—C.M.P.

NOLL, VICTOR H. "The Effect of Written Tests Upon Achievement in College Classes: an Experiment and A Summary of Evidence." Reprint from the *Journal of Educational Research*, January, 1939.

The available evidence on methods of motivating college and university students to high standards of accomplishment in academic work is not extensive. Most teachers believe that occasional short quizzes stimulate pupils to do better work, because the knowledge that a test is imminent motivates them to greater effort. The author summarizes the available literature in the field and describes his own experiment conducted over a period of two years in classes in educational psychology. In one class four quizzes were given at intervals of about three weeks. In a second class only a mid-term and final examination were given. Conclusions from this study: The results of the study indicate unequivocally that students in a class where no quizzes of any sort were used, other than a mid-term and final examination, show consistently though not substantially higher average achievement than is shown by students in classes where occasional written quizzes were given. In the case of less able students quizzes seem to have a greater effect on achievement than in the case of brighter students. It may be that when students have occasional quizzes they feel more secure and therefore take the longer examinations less seriously. There is no evidence here to support the common belief among instructors that written tests, as commonly used, motivate learning or increase achievement in college classes.

—C.M.P.

HURD, A. W. "What's New in Education." *The Hamline Review* 29: 7–12; January, 1939.

The real need in education is not so much a new idea as the direction of attention on ideas which have been stated before but which have not been put into practice. More attention is now being centered on the high school than on

the elementary school because the latter is better settled and its functions more firmly established. Then, too, pupils of high school age are causing more concern because of unemployment, ailing democracies, and mass propaganda.

In junior and senior high school more attention is being paid to making good and intelligent citizens—more cooperative citizens; to supplying a satisfactory scheme of life for pupils now, and not merely for a distant future life; a more thorough study of each individual; more and better vocational and educational guidance; and more emphasis upon education of the emotions. Curriculums are being arranged around functioning life-units rather than around non-functioning subject-matter compartments.

—C.M.P.

BAGLEY, WILLIAM C. "What Should Be the Equipment in the Natural Sciences of Teachers in Other Fields." Reprint from *Educational Administration and Supervision*, November, 1938.

This is a paper read at the Annual Conference on the Education of Teachers of Science held at Teachers College, Columbia University, April 29, 1938. The study of the natural sciences must be a major phase of any type of education which today is truly liberal. Teachers in other fields than science should have professional background courses in biological and physical science. These would be in the nature of survey courses, the physical science course covering at least a year and a half. —C.M.P.

RUSSELL, WILLIAM F. *Divided We Fall.* Reprint.

This is an address delivered at the annual dinner of the American Congress of Industry, Waldorf-Astoria, New York City, December 9, 1938. The address deals with the dangers of Fascism and thus is the complement of the author's address on Communism which has been commented upon often and has received wide distribution. —C.M.P.

COUNTS, GEORGE. "Whose Twilight?" *The Social Frontier* 5: 135–140; February, 1939.

This discussion is partially in response to an article in the December 17, 1938 issue of The Nation entitled "Twilight at Teachers College". The article maintained that after years of representing the cause of liberalism and democracy in education and society, that Teachers College had turned definitely toward reactionary thought and practices. Counts vigorously denies this, asserting that true academic freedom and liberalism is as much enthroned as ever, and that it exists to a greater degree at Teachers College than at probably any other institution of higher learning. —C.M.P.

SPENCE, RALPH B. "One Approach to the Appraisal of the Competence of High School Pupils." *Teachers College Record* 40: 507–520; March, 1939.

This article endeavors to show, by means of student judgments on problem situations in The Socially Competent-Person tests, one way in which the school may gather additional data on the appraisal of the general school curriculum and on the understanding of individual pupils.

—C.M.P.

NORTON, JOHN K. Status of the Federal Aid Issue. *Teachers College Record* 40: 483–494; March, 1939.

A brief history of the federal aid issue in education is presented. Issues in federal aid are discussed: federal aid with or without federal control; shall federal funds be earmarked for specific purposes; basis for apportioning federal aid to the states; and federal funds for non-public schools. A bill for federal aid to schools is pending in the Senate. —C.M.P.

WELLMAN, BETH L. AND STODDARD, GEORGE D. "The I. Q.: A Problem in Social Construction." *The Social Frontier* 5: 151–152; February, 1939.

The psychological literature was for many years deluged with reports of the "constancy" of the I. Q. as determined by correlation. More recently it has been found that the I. Q. is not as constant as once believed. The reason that that this was not discovered earlier was because investigators were not looking for change but for constancy, and little thought was given to the dynamics of environment. Faith in I. Q. constancy has been based on consistency on retest. The importance of environment, especially that in earlier years, is probably much greater than heretofore believed. Heredity, in many "resemblance" studies, appears to be defined as whatever is left over after environment is taken out. Thus it becomes imperative to give environment a maximum chance. —C.M.P.

ANONYMOUS. "The Rural Teacher's Economic Status." *Research Bulletin of the National Education Association* 17: 3–61; January, 1939.

The economic status of rural teachers as depicted in this Bulletin is deplorable and well might America hold its head in shame at the actual conditions revealed! The following major topics are discussed: (1) school salaries and other income, (2) use of income, (3) value of property and extent of indebtedness, (4) what rural teachers think about their economic status (10 case studies presented), and (5) summary of facts and conclusions. —C.M.P.

New Publications

AUSTIN, ALMA H. *The Romance of Candy.* New York: Harper and Brothers, 1938. 234 p. $2.50.

This is a fascinating story of candy-making, the eighth largest food industry in the United States. Candy has become such a common product that it is accepted by most people with little realization of the many processes involved in its manufacture; of the number of people concerned in growing and preparing raw materials; and of the great number of countries that supply the various ingredients used in common confections.

As a result of careful research, the author gives the reader authoritative information about the origin of candy making; about the various kinds of raw materials used in sweet-meats and how they are grown and prepared; about making different kinds of candy and how it is packed and made ready for sale; and about the importance of cleanliness and attractiveness of salesrooms. The author also emphasizes the food value of candy. Various phases of this important industry are illustrated by forty photographs that take the reader from the fields where the raw products are grown to the finished product in the display window of a retail shop.

This educational book should be of interest to students in secondary schools, to persons interested in making candy at home, to professional makers of confections, and to lay readers.

—F.G.B.

ALLEN, JOHN S. ET AL. *Atoms, Rocks and Galaxies.* New York: Harper and Brothers, 1938. 474 p. $3.00.

During the past two years a large number of new books have appeared in the field of Survey Courses. This book is another survey book in the Physical Sciences. In the preface the author explains that the text is the result of several years of experimental work in this field at Colgate University.

The book is well written and interesting. The subject matter is a bit difficult for the average freshman who may not have had any previous training in the subject matter of the book. The arrangement of the subject matter does not seem to have a connected sequence. For instance the first 212 pages of the book may be termed as the earth sciences. The next chapter then starts with energy. After energy, the structure of matter and chemistry, the authors again return to a study of the Universe. The sequence is attempted through the study of the earth and the solar system, but it is rather difficult to trace the intended meanings.

The distribution of the subject matter into the various academic subject matter fields is somewhat as follows: Astronomy 131 pages, geology 141 pages, physics 93 pages, and chemistry 91 pages. At the end of discussion of the subject matter there is a summary and list of questions. In addition there are references given which the student will find helpful in a study of the subject matter. The book is well illustrated. There are many good full page illustrations.

The subject matter seems to be accurate and only important basic principles are treated. There are many places where the authors become rather technical. The value of doing this does not become apparant when one considers that many of the students who take the course will never come in contact with these again.

The book will be found useful as a reference book but most certainly should not be used for high school work.

F. L. Herman.

YOUNG, CLARENCE W., STEBBINS, G. LEDYARD AND HYLANDER, CLARENCE JOHN. *A Survey in Biological Science.* New York: Harper and Brothers, 1938. 657 p. $3.00.

This is a text for a survey course in biological science, based on the course offered at Colgate University. The book presents a picture of the life of man. The major emphasis is on human life, although the first part describes plant and animal metabolism, and typical plant and animal structures. A comparison of this text with other biology survey texts reveals a wide divergence of content material. The reviewer is in accord with most of the textual material. The frank discussion on human reproduction will be welcomed by many teachers and hesitantly presented by others. The style is attractive to the student and the special attention to technical terms will ease many teaching difficulties. The approach is functional and the social implications are emphasized. Certainly a course in biology based on this text is far more preferable for the college student not majoring in science than would be a course in either botany or zoölogy.

—C.M.P.

SCIENCE MASTERS' ASSOCIATION. *The Teaching of General Science.* Part I, 1936, 49 p., Part II, 1938, 79 p. London, England: John Murray, Albemarle Street, W.

This is the committee report of the Science Masters' Association—a report that has created much discussion in England. American science

teachers would profit a great deal by reading the reports. General Science has had a much more difficult time gaining entree into English schools than it has in American schools. The reasons advanced by the committee for the introduction of General Science are: (1) utilitarian or vocational: it helps the pupils in their everyday life or may be necessary in their future occupations; (2) disciplinarian: it teaches them to think; it sharpens their minds; (3) cultural: its inclusion is desirable because it forms an essential part of our social heritage. Two quotations from the report: "Since the 'disciplinary' values of a subject cannot be urged as the main arguments in its favour, we must not include in our syllabuses any matter whatever which is taught only for the sake of the training it gives. It is no longer possible to defend a narrow curriculum by urging the claim that 'it trains boys to think and to appreciate scientific method.'—Of all the claims made for the inclusion of Science in a school curriculum, the strongest undoubtedly is that which stresses the cultural value which the subject possesses."

There is a rather detailed syllabus outlining the content to be taught. This content includes material from the fields of physics, astronomy, chemistry, geology, and biology. Some attempt is made at integration, and some emphasis is placed on generalizations. Thirty-five pages of Part II are devoted to optional content. The content would seem to be about on American senior high school level, rather than on junior high school level, where general science is usually taught in this country.

It is suggested that examiners make out their questions to test: (1) Acquisition of scientific information and knowledge, (2) Development of scientific modes of thought, (3) Application of scientific knowledge to socially desirable ends, and (4) Practical powers and skills.

—C.M.P.

LUCKIESH, MATHEW. *Color and Colors.* New York: D. Van Nostrand Company, 1938. 205 p. $3.00.

This is a book that should have wide appeal—in art, decoration, illumination, advertising, science—in most every phase of human activity. Here is a wealth of information—psychological, esthetic, scientific—that should enhance one's appreciation, enjoyment and understanding of color and colors. The author believes that this is a phase of life whose importance has been greatly underestimated. Mental color-blindness is endemic and is a partial explanation of the drabness of man's world. We live in a taupe age.

The primary colors are red, green and blue—not red, yellow and blue as commonly believed. Yellowish orange on deep blue or black and scarlet on greenish-blue offer the greatest contrasts. Men prefer blue followed by red. Women prefer red with blue a second choice. Deep orange has a maximum exciting influence; yellow maximum cheerful influence; green or yellow-green maximum tranquillity and violet maximum subduing influence.

The author, Dr. Luckiesh is our best known authority on lighting and color. In this non-technical book will be found an excellent supplementary book for college physical science courses and for the secondary science shelf. Any science teacher or layman will find the book interesting and profitable reading.

—C.M.P.

CRAIG, JOHN D. *Danger is My Business.* New York: Simon and Schuster, 1938. 309 p. $3.00.

This is a story of a man who lives with danger, whose life is a gamble with death to make a living. Indeed, the initial D might as well stand for Danger as for any other name—the author merely annexed it himself. The author might best be described as an adventure photographer, big-game hunter and deep-sea diver. The author has filmed sequences in 35 countries for leading motion picture companies. Parts of these have appeared in *Trader Horn, Devil Tiger,* and *I Cover the Waterfront.*

A fortunate oil well venture enables the author to do as he pleases—seek adventure wherever he can find it. And the years that follow are full of adventure and danger—capture by the Riffs, Climb of the Pyramids, the tiger hunt for The Club-Footed One and Rajah Pedapulli, deep-sea diving with sharks as spectators, octopuses, the broadcast from the bottom of Lake Michigan and many other adventures. Right now he and some friends are interested in salvaging treasures from ships that have gone down in Davy Jones' Locker—and specifically obtaining the gold of the Merida and the Lusitania. Much science is interspersed with all of this description and anyone interested in vicarious adventures will find in this book a surcease from "the tasks that infest the days." Few better books of this kind have been written. The book would make an excellent addition to the library shelf of any high school or public library.

—C.M.P.

SHAND, S. J. *Earth Lore.* New York: E. P. Dutton and Company, 1938. 144 p. $1.75.

This is certainly one of the very best, if not the best, popular treatise of geology suitable for the high school pupil or layman, that has yet appeared. Science teachers—elementary, junior high school and senior high school—will find this a most enjoyable book. The author has an unusual ability to hold the readers attention through his most readable style and apt analogies and illustrations. The discussions on drifting continents, lost continents and the age of the earth are especially fine.

—C.M.P.

BLACK, MARVIN M. *The Pendulum Swings Back.* Nashville: Cokesbury Press, 1938. 229 p. $2.00.

The pendulum is philosophic thought and it is swinging back from materialism to idealism, to "that philosophy which finds the world ultimately meaningful and intelligent"—to "the pursuit of the ideals of truth, beauty and goodness," back to "the great tradition." The author lists nearly three hundred volumes dealing with various phases of philosophy, nearly all written within two decades. It is this literature of the subject he is trying to digest and interpret.

The reviewer never feels the need of Divine revelation quite so keenly as when treading the mazes of philosophy. If the philosophers would only come to an agreement. The pendulum seems to swing everlastingly. This volume is clear, concise and stimulating. Perhaps it will help bring the pendulum to rest.

—E.R.D.

PRICE, JACK. *News Pictures.* New York: Round Table Press, 1937. 192 p. $3.50.

This is a most interesting book even to those not interested in any practical phase of photography. Few people live more adventuresome lives than do working news cameramen. Many interesting bits of their work is both described and illustrated in this book. But also the book contains much of the information that camera-users want to know: how to obtain feature pictures, sell them, best camera for various types of photography—sports, features, society and so on. Focusing, sighting, exposure, developing, enlarging are technical processes described. This is an excellent reference book for anyone interested in the commerical aspects of photography.

—C.M.P.

BLAIR, JULIAN M. *Practical and Theoretical Photography.* New York: Pitman Publishing Corporation, 1938. 237 p. $2.00.

The material in this book was originally planned for use in college classes in photography, much of the material being collected while the author was teaching photography for more than fifteen years. Those desiring a fairly simple, interesting, popular treatise on methods in photography will find it in this book. Some of the topics covered include: Cameras and developers, development, printing by contact, enlarging, exposure, portraits, lens intensification, reduction, lantern slides, natural color photography, coloring, toning, spotting and retouching, night photography, silhouettes, composition, fixing, washing, density, and formulae for developers.

This book is recommended for the secondary-science book shelf.

—C.M.P.

NEBLETTE, C. B. *Photography, Its Principles and Practice.* New York: D. Van Nostrand Company, 1938. 590 p. $6.00.

This is the third edition of a text book that is without a peer in its field. It is the standard reference in photography. There are complete descriptions and full directions for every photographic method and process. Numerous illustrations make clear much of the textual discussion. Carefully selected photographs clarify the directions for obtaining the best results in the practical aspects of everyday photography.

Complete formulas are given for the preparation of emulsions, developers, fixing baths, reducers, intensifiers and toners. The vocabulary is not overly technical, being within the comprehension of secondary school students. It is an excellent reference book for the science shelf.

—C.M.P.

RAND MCNALLY. *Standard Atlas of the World.* Chicago: Rand, McNally and Company, 1938. 382 p. $3.00.

Most everyone has use for a good atlas. Here is one of the most practical—whether the office, home or school. It is almost a World Almanac in the amount of information contained, the most noteworthy feature being the excellent 4-color maps covering the entire world. A list of the partial contents: (1) star maps, (2) solar-system chart, (3) maps of the world, (4) maps of United States and each individual state, (5) economic maps of the United States, (6) maps of foreign countries, (7) U. S. railroad mileage map, (8) U. S. highway mileage map, (9) interesting and historical facts of each state in the union, (10) descriptive facts about each state in the union, (11) interesting places in the U. S., (12) altitudes of principal world cities, (13) seven wonders of the ancient world, (14) seven scientific wonders of the world, (15) seven natural wonders of the world, (16) index of U. S. counties, (17) index of U. S. cities and towns, (18) index of foreign cities, and (19) pronouncing gazeeter of principal world cities.

—C.M.P.

RIDGLEY, DOUGLAS C. AND EKBLAW, SIDNEY E. *Influence of Geography on Our Economic Life.* Chicago: The Gregg Publishing Company, 1938. 658 p. $1.84.

The purpose of the authors in writing this book "is to help American youth to become acquainted with everyday surroundings and to sense the influence of these surroundings on current economic and social activities."

A background for understanding and interpreting economic geography is given in a discussion of physical factors in the environment. This is followed by a consideration of the races and occupations of man; of climate as it relates to the economic activities of man; and of the important facts of economic geography.

The content is organized in units. Exercises in the nature of assignments for self-directed study by the student are given at the close of each chapter. Many excellent maps, pictures, and charts aid in interpreting textual material. All of these have unusually fine legends which are stated in such a way that problems are raised.

—F.G.B.

RIDGLEY, DOUGLAS C. AND EKBLAW, SIDNEY E. *Problems in Economic Geography.* Chicago: The Gregg Publishing Company, 1938. 203 p. $1.00.

Although this workbook is designed to accompany *Influence of Geography on Economic Life* by the same authors, it is organized in such a way that it may be used independently or with other texts relating to the subject. It contains 277 exercises outlined for 80 lessons.

It is well illustrated with excellent maps and graphs that are essential in working out the exercises and problems. Space is provided for recording facts and relationships derived from a study of the exercises.

Suggestions for the use of this workbook are given in the teachers handbook that accompanies *Inflence of Geography on Our Economic Life.*

—F.G.B.

RIDGLEY, DOUGLAS C. AND EKBLAW, SIDNEY E. *Influence of Geography on Our Economic Life. Tests. Teachers Edition.* Chicago: The Gregg Publishing Company, 1938. 24 p. $0.15.

This is a teacher's edition of tests to accompany *Influence of Geography in Our Economic Life.* For testing purposes, the book is divided into four sections. There is also a final test designed for classes completing the book at the close of the first semester and one of those completing the book at the close of the second semester. In each of the sections there are four kinds of tests—yes and no test, multiple choice test, completion test, and essay test.

—F.G.B.

EINSTEIN, ALBERT AND INFELD, LEOPOLD. *The Evolution of Modern Physics.* New York: Simon and Schuster, 1938. 313 p. $2.50.

This book carefully and clearly builds the background of classical mechanics necessary to an understanding of the more energy. The history of the concept of field, and its place and importance in physical theory is then sketched and the difficulties described which led to the formulation of the general and special theories of relativity. The last section presents the wave vs. particle dilemma, and explains the quantum theory and its place in attempting to solve the problems set by recent developments in experimental physics. This is a highly enlightening and easily readable book. The first half, dealing with the rise and fall of the classical mechanical approach is even clearer at points than many treatments in high school physics texts. The part dealing with the theory of relativity is probably as clear as any attempt can be, to present highly mathematical concepts, and of such a nature that they cannot be visualized concretely, without the use of mathematical symbolism. It is an unusually "unifying" book. It brings out the relationships between the various phases of the development of physical theory, and shows clearly how each new advance is another step added to a stairway which extends downward into the past.

—O. E. Underhill.

WRIGHT, RICHARDSON. *The Story of Gardening.* Garden City, N. Y.: Garden City Publishing Company, 1938. 432 p. $1.98.

The story of gardening from "the hanging gardens of Babylon to the hanging gardens of New York" gives a detailed and fascinating account of the development of gardening as an art, in many lands. The book is profusely illustrated with cuts and photographs. Monastic and Mediaeval gardens, the symbolism of the Japanese gardens, gardens of Greece, Rome, India and England are but a few of the many types of gardens described. A chapter is devoted to the rise of gardening in America.

—O. E. Underhill.

RIDGLEY, DOUGLAS C. AND EKBLAW, SIDNEY E. *Influence of Geography on Our Economic Life. Teachers Handbook.* Chicago: The Gregg Publishing Company, 1938. 64 p:

This handbook is written to help teachers in using the textbook, *Influence of Geography on Our Economic Life,* written by the same authors. The point of view of the authors and many suggestions for using the text are given, such as those relating to the globe, maps, charts and graphs, those concerned with choosing subjects for individual investigations, field trips, exhibits, visual aids, tests, and lesson assignments based on the text and workbook.

This handbook should be a valuable help to all teachers using the text and workbook by the same authors.

—F.G.B.

ANONYMOUS. *Health in Colleges:* Proceedings of the Second National Conference on College Hygiene. New York: National Tuberculosis Association, 1937. 112 p.

The sponsoring organizations, namely the Presidents' Committee of Fifty on College Hygiene, the National Health Council, and the American Student Health Association, for many years have been solidly behind a movement for the improvement of college programs of hygiene. In 1922 the Presidents' Committee of Fifty was set up "to stimulate the development and extension of instruction and training of hygiene in normal schools, colleges, and

universities." The Committee's report was published in 1927 and widely distributed with the assistance of members of the National Health Council. In 1930 the American Student Health Association became interested in the movement, and the next year the First National Conference on College Hygiene was held under the joint sponsorship of all three organizations "to focus the attention of our most competent authorities upon the identification of the basic problems of college hygiene; secure their expert analysis of those problems; and then have them formulate a consequent statement of their conclusions."

The Proceedings of the Second National Conference on College Hygiene disclose the growing responsibilities of college authorities for student health. Dr. Livingston Farrand, President of the Conference, says that there is revealed "a distinct advance in breadth of vision and understanding of the many factors concerned with the health of college students. . . . In our present view, health is a condition of well-being which embraces physical, mental and emotional hygiene, and controls to a very large extent, personal and social behavior." But,—he calls attention to a survey made in 1936 by the United States Office of Education concerning the status of health instruction which "reveals the fact that only a third of our colleges and universities have required courses in hygiene." Between the general acceptance of common scientific objectives in educational hygiene and their practical application there still lies a great gulf.

The Proceedings present definitely the legal, social and educational aspects of the problem with details on the organization and administration of student health service and health teaching. A thorough investigation of the physical, mental and social health status of all new students either graduate or undergraduate is recommended before matriculation is complete; annual health examinations thereafter. For each 500 resident students one full time physician and a resident psychiatrist are recommended. The importance of mental hygiene is emphasized. A required course in general hygiene of not less than two semester hours, with credit given, is urged. Its content, methods, materials and evaluation procedures are outlined. The comprehensive program of physical education presented urges cooperation between this department and the health teaching staff through the coordination of the activity program with the teaching of health habits, attitudes and knowledge.

Social hygiene in its larger sense deals with a large group of health and welfare problems which concern several college departments and run through many courses. Although specific sex instruction should be given in courses in hygiene the committee emphatically approves the decided trend in American colleges towards centering most of the instruction on social health in general courses on the family. Other recommendations are that colleges: include among the credentials for admission the records of health examinations of students in high school; adopt standards named by the National Tuberculosis Society; strengthen all aspects of physical and mental health in the education of teachers.

A study of the Proceedings is highly recommended to administrators, teachers, personnel officers, student counselors, physicians, psychiatrists, dieticians, athletic directors and curriculum makers.

—C.E.B.

MOON, TRUMAN J. AND MANN, PAUL B. *Biology.* New York: Henry Holt and Company, 1938. 966 p. $2.60.

Biology is a revision of *Biology for Beginners,* 1933 edition, a text that has been used widely by high school students. The revision was made in order to bring the content up to date; to enrich and elaborate certain phases relating to mitosis, invertebrates, embryology, paleontology, anthropology, human tissues, vitamines, ductless glands, genetics, and experimental evidence on the effects of alcohol; to add more than fifty new especially appropriate photographs and line drawings; to add a complete classification of plants and animals; and to make more complete the glossary and index. A minimum reference library for pupils and teacher is given to which specific references are made in connection with the work in each chapter. At the close of each chapter are included a list of questions relating to the content, references to further suggested readings, practical suggestions for things pupils can do, and a list of new terms included in the chapter.

All teachers of biology in secondary schools will be interested in this revision of a book that is well known and has proved its worth with young people.

—F.G.B.

HOGG, JOHN C. *An Introduction to Chemistry.* New York: Oxford University Press, 1938. 365 p. $2.00.

The historical approach to chemistry is emphasized in this book. In the words of the author, "this new emphasis must be the justification for adding to the existing formidable array of the school chemistry books." The book is intended for use with students on tenth and eleventh grade levels "who wish to lay a sound foundation before proceeding to a more advanced study of inorganic chemistry and also those who study chemistry as a cultural subject and as a means of gaining some insight into scientific procedure."

This is a clear, interesting, dignified, well written book in chemistry for secondary schools. Because of its approach it will be of special interest to teachers.

—F.G.B.

RICE, THURMAN B. *A Textbook of Bacteriology.* Philadelphia: W. B. Saunders Company, 1938. 563 p. $5.00.

This textbook for medical students and practicing physicians is a revision of one published in 1935. The purpose of the new volume is "to bring the text up-to-date, to fill in certain omissions, to correct any inaccuracies, to make clear such passages as may be found confusing by the student, and in order that suggestions for improvement that have been made from time to time may be accepted." Some new subjects are covered in this edition, such as the typing of the pneumococcus, sulfanilamide therapy, and the use of tetanus alum-toxoid. Long detailed descriptions of cultural characteristics, detailed laboratory techniques, and long discussions of controversial subjects have been omitted. Practical phases of the subject are emphasized, such as diagnosis, prognosis, etiology, collection of specimens for laboratory, interpretation of laboratory findings, treatment, specific therapy, prophylaxis, and sanitary control. The technical processes described may be carried out by practicing physicians who are limited in time, material, and equipment.

This book is written in a clear, forceful style; is well illustrated by line drawings and photographs; and has an important appendix. It is a valuable text for the college student in bacteriology and to the practicing physician. It is a valuable reference book for the lay reader.

—F.G.B.

WHITNEY, FREDERICK LAWSON. *The Elements of Research.* New York: Prentice-Hall, Inc., 1937. 616 p. $3.50.

This is a much more complete and comprehensive book than the author's former *Methods in Educational Research.* Although the new title doesn't imply a restriction to educational research, the book probably fits best situations which are now current in classes in educational research.

Chapters VII to XIV, inclusive, which emphasize varied aspects of research discuss descriptive, historical, experimental, philosophic, prognostic, curriculum, sociological, and creative research. The first six chapters introduce considerations of scientific method, research traits, problems, and methods of attack; the last two chapters summarize procedures in classification, generalization, statistical form, and preparation of the research report. Copious reference to previous educational investigations and reports is made throughout the book.

The author is to be congratulated on his common-sense and understandable treatment of the whole subject which will undoubtedly appeal to many students in classes in educational research. The book is attractively printed and bound.

—A.W.H.

LEWIS, JOHN R. *An Outline of First Year College Chemistry.* New York: Barnes and Noble, Inc., 1938. 318 p. $1.00.

This book represents an attempt to cover the essential material usually found in first year chemistry in such a manner that the student can readily find information and review easily. The usefulness of this book depends, to a certain extent, upon what material a teacher emphasizes in his course and also upon the methods of study employed by the student. A large number of topics are covered in this outline but because of its size the material on any one topic is rather meagre. The appendix contains a number of useful tables. Some of the definitions included in the table of definitions are very poor and will be misleading to the student.

—P. E. Hatfield.

WILLIAMS, SAMUEL H. *A Laboratory and Field Guide to Biology.* New York: The Macmillan Company, 1938. 130 p. $1.25.

This valuable guide is designed to direct students of natural history in their study of living things in laboratory and field. It is a revision and elaboration of the *Systematic Guide to Field Zoology* which the author has used for eight years in his classes in the University of Pittsburgh. It is a practical guide to be used with *The Living World* written by the same author. The manual includes fifty-five exercises dealing with topics, such as the following: the use of the microscope; cell structure and one-celled organisms; fresh water coelenterates; flatworms; segmented worms; a comparison of a caterpillar and a worm; mollusks; crayfish; spiders and other arachnids; myriapods; insect anatomy; structural modifications of honey-bee legs; adaptive radiation of legs of insects; mouthparts of the honey-bee; comparative insect studies; ant studies; insect respiration; study of fish; study of frog; some features of snakes; bird descriptions; bird structures; bird study in fields; introductory field studies; classification of all animals collected; woodland animals; animals of open fields; a dead log association; life in a pond; animals of rapid brooks; common water animals; stream flow reactions; aquarium studies; plancton organisms; carrion insects; subterranean animals; cave animals; animals found in open beaches; animals found in the drift line; animals on the sea shore; sand dunes and their inhabitants; nocturnal animals; the clay bank association; animal coloration; defense mechanisms of plants and animals; simple plants; mosses; liverworts; ferns; higher plants emphasizing root, stem, bud, leaf structure and function; photosynthesis; flower and seed; spring flowers; carnivorous plants; plant association; school herbarium; plant and animal relationships; plant galls; and tree study.

—F.G.B.

BRINKLEY, STUART R. *Introductory General Chemistry.* New York: The Macmillan Company, 1938. 731 p. $3.00.

The new texts in General College Chemistry have been many and varied. This revision by Prof. Brinkley of his older text presents many of the newer and more up to date concepts in chemistry. The book as a whole is much improved. The underlying Philosophy as presented by this newer text from the author's preface states that (1) "to afford an insight into the scientific method of thought which differentiates the civilization of today from all that have preceded and (2) to develop a rational basis for an understanding of the true significance of chemistry in the modern world, and (3) to coordinate the facts, laws and theories of chemistry into an orderly science."

A summary of the achievements of the aims in modern teaching seems to indicate that Prof. Brinkley has rather successfully accomplished a high degree of correlation between subject matter as such and the development of the scientific method. His text places the emphasis upon the major principles of chemistry without any neglect as to the factual content which establishes the principle. Numerous applications of chemistry have been added and much new material has been included. There are numerous problems or exercises at the end of each chapter. At the end of each chapter is a list of supplementary readings which is good in the sense that it is sound authoritative material.

It seems to this reviewer that there is plenty of material for the student to work with but which leaves the instructor with little to do but add to the subject matter material and to emphasize the principles set forth in the book. It will be found that the arrangement of the text is logical as to sequence from the point of view established by the author. This is a really exciting textbook in chemistry in that it is well written and easy to understand. The student should experience no difficulty in using the text. It is recommended for class use as a text and as a reference.

—F. L. Herman.

DIETRICH, HAROLD G. AND KELSEY, ERWIN B. *Laboratory Manual to Accompany Introductory General Chemistry.* New York: The Macmillan Company, 1938. 336 p. $1.90.

The publication of the second edition of Brinkley's Introductory General Chemistry has brought forth a revision of the accompanying laboratory manual by Dietrich and Kelsey.

The book is divided into two sections; the first contains the type of experiments usually employed in general chemistry, while the second section is devoted to qualitative analysis. One side of each page is blank to allow the student to use the book as a laboratory notebook. Spiral binding is employed.

This manual contains more material than the average student can cover. However, some of the experiments such as the one on rate of reaction are excellent for the better student.

The qualitative section departs from the usual arrangement; anion analysis preceeds cation analysis. Only the more common ions are included in the schemes.

This is an excellent manual for general chemistry although this reviewer would prefer semi-micro schemes in the qualitative section.

—P. E. Hatfield.

DICTER, MORRIS RICHARD. *The Relationship Between Scores on the Scholastic Aptitude Test and Marks in Mathematics and Science.* Philadelphia: Author (2313–76th Av.), 1937. 57 p. $1.00.

This is a doctor's thesis investigation carried out at the University of Pennsylvania. The study aims to discover the relative validity of the prediction of scholastic success in college mathematics, chemistry, and physics courses from scores in the verbal and mathematical sections, respectively, of the college aptitude test taken before entrance to college.

From a total of 158 correlation coefficients computed, the investigator concludes that the scores on the mathematical sections are of more predictive value in every case. Coefficients range from about .10 to about .60 but for mathematical sections are, with but three exceptions, above .40. Verbal sections show highest predictability for physics, coefficients ranging from .30 to .40.

—A.W.H.

MCVITTIE, G. C. *Cosmological Theory.* New York: Chemical Publishing Company, 1938. 100 p. $1.25.

This is a highly mathematical treatment. The first brief chapter gives a survey of the observational material on which the theory is based. Chapter two gives an explanation of the tensor calculus. Chapter II gives an analysis of the general theory of relativity necessary for an understanding of the theory of the expanding universe, which is developed in Chapter IV. All of this is by way of preliminary to the fifth chapter which presents the purpose of the book. The recession of spiral nebulae has little resemblance to gravitational phenomena. Therefore it becomes pertinent to attempt to construct a theory of the universe without an *a priori* appeal to a theory of gravitation. E. A. Milne has set the problem of first building up a theory of the whole universe and then deducing from it the necessity of small-scale gravitational motion, and has given one solution. The author presents another approach, which he has termed the kinematical theory of the universe. The mathematical background of the reviewer is far too inadequate to allow him to comment on this presentation.

—O. E. Underhill.

HIRSCHLAFF, E. *Fluorescence and Phosphorescence.* New York: Chemical Publishing Company, 1938. 128 p. $1.50.

A highly technical treatment of this subject. A thorough treatment of the various aspects of fluorescence and phosphorescence in terms of the excitation of atoms and molecules. Requires thorough background in quantum mechanics and the physics of radiation.

—O. E. Underhill.

SULLIVAN, J. W. N. *Science: A New Outline.* New York: Thomas Nelson and Sons, 1935. 283 p. $2.00.

Another excellent general treatment of the nature and meaning of science for the educated layman by a well-known author of this sort of writing. This book gives a good unifying picture of science and its interpretations. Divided into two "books" covering respectively physical and biological phenomena, Book I deals with the earth's dimensions, constitution, motions and origins, gravitation, atomic structure, radiation and "The New Outlook." The first sections form an excellent background for the treatment of relativity which follows. Each popular treatment of relativity seems to move nearer toward making it understandable to the non-technically trained individual. This is one of the best treatments of the shift in viewpoint from Newtonian physics to Einstein's theories that the reviewer has seen. Book II, in two sections, deals with the fundamental units of life, and evolution.

It is perhaps straining at a gnat, in view of the author's mastery of his field and extreme lucidity of expression in handling a difficult area of knowledge, to mention a minor detail. It seems to the reviewer that to say that the earth "floats unsupported" in space is a contradiction, unless one uses a pre-Archimedes definition of the meaning of float.

—O. E. Underhill.

SCHMIDT, EMERSON P. (Editor). *Man and Society.* New York: Prentice-Hall, 1938. 805 p. $3.75.

Thirteen authors have written this introduction to the social sciences in sixteen chapters. It is intended to be used as an orientation course at college level. It might well serve to orient Mr. Averageman as well as college students. He would be a much more intelligent citizen if he would read it. And it is not hard to read. It is clearly and interestingly written. The chapters on Psychology and Its Applications, Modern Criminology, Popular Participation in Government, The Mechanics of Government, The Distribution of Incomes, Economic Security will be read with avidity by the man on the street once he gets hold of the book for they discuss so many topics that are current issues. The teacher of natural science will appreciate the excellent discussion of the scientific method in the chapter on Causal Relationships. It will afford him applications of the method to everyday problems outside his own particular field.

—E.R.D.

AVERY, MADALYN. *Household Physics.* New York: The Macmillan Company, 1938. 439 p. $3.50.

This is a textbook for college students in Home Economics. It is based on the author's experiences in teaching a course in Household Physics at Kansas State College of Agriculture. The course consists of three lecture-recitation periods and one three-hour laboratory per week for one semester.

The reviewer is very much pleased with the content material and its method of presentation. More material along this line presented in high school courses might have prevented somewhat the great decline in that subject during the last decade or so. The contents cover the usual field—mechanics, magntism, electricity, heat, light, and sound, but emphasizes materials common to the everyday experiences of the pupils. Some topics not usually found in college physics are refrigeration, household water supply and sewage disposal, air conditioning in the home, the weather, electrical heating devices in the home, household motors and so on.

This text would be an excellent reference book for high school pupils in physics courses and college physical science survey courses.

—C.M.P.

WOODRING, MAXIE NAVE AND SANFORD, VERA. *Enriched Teaching of Mathematics in the Junior and Senior High School.* New York: Bureau of Publications, 1938. 133 p. $1.75.

This is a source book for teachers of mathematics, listing chiefly free and low cost illustrative and supplementary materials. Teachers in the various fields of mathematics will find this a most useful guide if they feel the need of supplementary materials, but do not know where to find them. The contents are as follows: (1) Materials for units in Arithmetic, (2) Tests and Workbooks in Arithmetic, (3) Workbooks in Junior High School Mathematics, (4) Materials for units in intuitive geometry, (5) Materials for units in numerical trigonometry and surveying, (6) Materials for units in Algebra, (7) Tests and workbooks in Algebra, (8) Materials for units in demonstrative geometry, (9) Tests and workbooks in geometry, (10) Trigonometry tables, tests and workbooks, (11) Commercial Mathematics tests and drill exercises, (12) Miscellaneous tests, (13) Assemblies and Mathematics clubs, (14) Excursions, (15) Classroom equipment, pictures and exhibits, (16) Bibliographies, periodicals and yearbooks, (17) History of mathematics, and, (18) Addresses of sources.

—C.M.P.

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